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CHANGING SUGAR TECHNOLOGY AND THE LABOUR NEXUS
IN THE BRITISH CARIBBEAN, 1750-1900, WITH SPECIAL
REFERENCE TO BARBADOS AND JAMAICA

I

Technology can be defined as the organization of knowledge for the achievement of practical purposes. It consists of knowledge, skills, methods, tools, and machines that enable people to shape materials and produce objects for practical ends. In this paper I will examine the pattern and direction of technological change in the cane sugar industry of the British West Indies and analyze the impact of this change on the employment, productivity, and welfare of workers engaged in the production of sugar. I will use the term "technology" in a comprehensive sense to include techniques and such non-material aspects as management, organization of work, and other elements of social organization. I plan to compare the sugar islands of Barbados and Jamaica from *circa* 1750 to 1900 in terms of innovations which changed the processing structure, changes in the agricultural sphere, and connections between technological developments and changing labour relations. I shall be concerned with the geographic environment and the technology which made that environment useful; with the availability of capital, access to skilled and unskilled labour, presence or absence of members of the planter class, metropolitan influences, changing sugar prices, duties, and profitability. Barbados, with its high density labour force and compact and relatively uniform physical characteristics, will be contrasted with Jamaica, its low density labour force and extended and diverse physical characteristics (Barbour 1980: 30, 35-36).

I.Z. Bhattu maintains that since agriculture is basically a biological process, it is important to distinguish between mechanical and biological technology. "The former", he writes, "makes non-human power available

or provides the means through which non-human power could be productively utilized, in place of human or animal power." Prior to the application of steam power to the sugar industry, non-human mechanical power took the form chiefly of horse-mills, windmills, water-mills, and tide-mills to crush the canes. Biological technology, on the other hand, improves animal and plant production by increasing the effective supply of nutrients. Plant productions can be increased by either increasing the effective supply of nutrients available or by making it possible for the plant to utilize larger amounts of available nutrients, or, both. Fertilizers and assured water supply are means of the first kind, improved seeds or plant material of the second (Bhatty 1978: 3-11).

The typical sugar plantation of the British West Indies has been described as a factory in the field. The agricultural processes of land preparation, cane-planting, weeding, and cutting were combined with grinding the canes, boiling the cane juice, curing and refining the sugar, and distilling the molasses into rum. This combination of biological and mechanical technology was made necessary by the inherent perishability of the crop. Owing to its rapid fermentation, the newly-cut sugarcanes had to be milled within about twenty-four hours if sugar of marketable quality was to be produced. Milling time was thus limited, while on the other hand transport from the field to the mill was slow and cumbersome. Richard Pares (1960:24-5) has calculated that a muscovado sugar factory could not profitably serve an estate or plantation of more than 300 to 350 slaves, tending an acreage of sugarcane which probably would not exceed 300 in all. Managing a sugar plantation, which usually combined agriculture with a processing plant or "sugar-works", was a complex affair. It required foresight, calculation, and coordination. In his *Essay Upon Plantership*, Samuel Martin of Antigua said that a sugar plantation "ought to be considered as a well constructed machine, compounded of various wheels, turning different ways, and yet contributing to the great end proposed; but if any one part runs too fast or too slow, in proportion to the rest, the main purpose is defeated" (Martin 1802: 57-8; see also Barrett 1965: 147-70; Mintz 1986: 19-73; Smith 1975: 57-77; Sheridan 1974: 102-23).

To a greater degree than the other British sugar islands, Barbados was the island where the sugar plantations came to be conducted as if they were "well constructed machines". David Watts has shown how the sugar revolution of the mid-seventeenth century had the effect of removing practically all of the standing forest of Barbados by 1665, that the planting of canes in trenches or furrows led to destructive soil erosion which heavy applications of animal manure did little to correct, and that the development

of cane hole agriculture, while it imposed inordinately severe labour requirements on the field slave, led to a sustainable system of sugar cane farming after the early years of the eighteenth century. Under the "driving system", cane holes were dug by gangs of slaves who were drawn out in a line, like troops in a parade. Goaded on by black drivers who wielded cart whips the slaves raised and chopped down with their hoes in unison, as they moved forward from one row of cane holes to the next. This was the most conspicuous and enervating part of the new industrial labour discipline which, as Robert W. Fogel asserts, was the sugar planters' "greatest technological achievement, the foundation of their economic success, and the ugliest aspect of their system". Other innovations resulting from soil deterioration and soil loss were extending the growth period of cane prior to harvest from 15 to 18 months, improved and extended manuring practices, and specialized dung farms (Watts 1987: 391-405; Sheridan 1985: 148-54; Fogel forthcoming¹).

The statistics shown in Table I indicate that while the slave population of Barbados increased by about 33 percent from circa 1700 to 1775, the output of sugar declined by 27 percent, and the value of exports to Great Britain increased by 44 percent.

TABLE I: BARBADOS AND JAMAICA COMPARED, CIRCA 1700 TO 1775:
SLAVE POPULATION, SUGAR OUTPUT, VALUE OF EXPORTS TO GREAT BRITAIN

	Year	Slave Population	Sugar Output (tons)		Value of Exports to Great Britain £ Sterling
Barbados	1687	--	--		196,532
	1710	52,337	7,690		--
	1773	68,548	5,634	(1770)	282,652
Jamaica	1697	--	--		70,000
	1703	45,000	4,321		--
	1778	205,261	36,519	(1770)	1,384,420

Source: Campbell 1774: II, 669; Williams 1944: 226; Pares 1960: 84.

Part of the explanation of why there was a decline in sugar output in a period when the value of exports from Barbados to Great Britain increased is that a greater proportion of the sugar consisted of clayed, or semi-refined, which commended higher prices than muscovado sugar in British markets. Another part of the discrepancy is that raw cotton production and exports increased relative to that of muscovado and clayed sugar. Included among the factors that contributed to the decline in the sugar

output of Barbados were wartime losses, drought and hurricanes, epidemic disease, slave mortality and morbidity, emigration of planters and their slaves to other sugar colonies, absentee proprietorship, loss of soil fertility, and decline in crop yields. Handler and Lange (1973: 34-41) have estimated "that during most of the plantation slave period there were, on average, close to 400 medium and large plantations which contained between 100 to 200 slaves. In addition there was a large number of small-holdings which contained eight or ten acres, or more, with slaves in proportion". By using such criteria as land ownership, public offices held, and rank in the military, Watson (1975: 64-78) finds that "approximately 120 families dominated island history from the early period of colonization and even into present times, many of these families still ranking among the island's elite, now known as 'high whites'".

By the middle decades of the eighteenth century the sugar planters of Barbados had arrived at a capital-intensive, power-intensive, and labour-intensive system of sugarcane agriculture that was conducted on a sustained-yield basis, albeit with a net annual decrease in the slave and livestock populations. It was the judgment of Sir Robert Schomburgk, the mid-nineteenth century historian of Barbados, that "a rational management replaced by artificial means the former fertility" of the island. Indeed he affirmed that the island had "not undergone deterioration since Governor Sir Jonathan Atkins's time (1674-80), when it was considered to have reached its meridian prosperity, - a period which has been styled the golden age of Barbados" (Schomburgk 1848: 140-141).

By the standards of the seventeenth and eighteenth centuries, Jamaica was a large sugar island. It was nearly twenty-seven times as large as Barbados, measured in square miles. It is misleading, however, to compare these two islands solely on the basis of physical size. Barbados is only 21 miles long en 14 miles wide. It has an area of 166 square miles (106,000 acres), and it has been densely populated for some three centuries. It was very flat, with rising terraces which culminate in Mount Hillaby, the highest point, 1,115 feet above sea level. With the exception of the Scotland District in the northeast, Barbados is of coral limestone formation, which has weathered to generally fertile, well-drained and loamy soils on terraces. Moreover, the rainfall is generally adequate and distributed seasonally to grow the sugarcanes, and the trade winds are persistent and generally of sufficient strength to power the windmills (Watts 1966: 4-14; Handler & Lange 1978: 9-15).

While Barbados has been a sugar island of intensive monoculture for nearly three centuries prior to recent decades, Jamaica developed as an

island of extensive sugar monoculture only during the century prior to slave emancipation in 1838. We shall see that it subsequently developed a mixed economy of plantation and peasant agriculture in which sugar production and exports declined relative to those of other staples. Jamaica, which lies approximately 1,200 miles to the west of Barbados, is about 145 miles long with a maximum width of about 50 miles and an area of 4,411 square miles. More than half of the island consists of rugged slopeland lying 1,000 feet or more above sea level, with a range of mountains running east and west which reach a height of 7,500 feet in the Blue Mountains in the eastern part of the island. The moisture-laden trade winds dump 200 or more inches of rain on the higher slopes of the Blue Mountains, while the southern and western lowlands, lying in the rain shadow, are often too dry for agriculture without irrigation. There are three parts of Jamaica that are suited to the production of sugar: coastal areas; land along the lower basins and deltas of large rivers; and fertile inland valleys (Hall 1959: 13-14; McPherson 1963: 31-51).

The beginning of the sugar industry of Jamaica is generally credited to Governor Sir Thomas Modyford, the former planter-governor of Barbados, who arrived in Jamaica in 1664 with some 700 planters and their slaves. This was the beginning of a long association which was noteworthy for the transfer from Barbados to Jamaica of planters, slaves, capital, and mechanical and biological technology. The sugar industry grew rapidly for several decades after Modyford's arrival, but was severely handicapped during the greater part of the period from 1689 to 1713 by wars with Spain and France. There was another growth spurt after the Treaty of Utrecht in 1713, but it was halted in the decade of the 1730s by severe drought, depressed sugar prices in England, and internecine warfare against the Maroons, communities of ex-slaves that found refuge in the rugged interior of Jamaica and lived by hunting wild game, growing food crops, and raiding frontier plantations and settlements. After the treaty with the Maroons in 1739, however, "settlements began to be formed in those parts of the country where none chose to venture before". From approximately 70 sugar plantations in Jamaica in 1675, the number increased to 419 in 1739, 648 in 1776, and 775 in 1774 (Sheridan 1974: 92-5, 208-23, 420; Long 1774: I, 427-9; MacPherson 1805: III, 505).

Table 1 above supplies some key indicators of the growth of the Jamaican sugar industry from circa 1700 to 1775. The slave population increased five-and-a-half times; sugar output, eight-and-one-half times. In 1770 sugar and rum made up 87.7 percent of the value of all exports from Jamaica to Great Britain, Ireland, and North America which amounted to £1,538,730. Other exports in 1770 consisted of cotton, coffee, ginger, pimen-

to, sarsaparilla, mahogany, and hides. A similar calculation of Barbados's exports to Great Britain, Ireland, and North America shows that sugar and rum accounted for 62.5 percent of all exports which amounted to £ 432,013 in 1770. Other exports from Barbados in 1770 consisted of cotton, aloes, ginger, and hides (Campbell 1794: II, 661-6, 669).

An important biological innovation contributed to the expansion of Jamaica's sugar economy. Bryan Edwards, the planter-historian, wrote that "Guinea-grass may be considered as next to the sugar-cane, in point of importance, as most of the grazing and breeding farms or pens throughout the island, were originally created, and are still supported, chiefly by means of this invaluable herbage." Guinea grass was introduced into Jamaica from West Africa by George Ellis, Chief Justice, in the period 1736-1740 (Edwards 1793: I, 185-6).

The Jamaica planter elite profited from a system of sugar production which spread dear capital and labour thinly over the rich resource base. Large land grants and low taxes enabled the planters to hold reserve tracts at a low cost for purposes of speculation or future expansion of sugar production. According to Edward Long, the Jamaica planter-historian, almost all of the overseers on the island

consider the number of acres they can annually overspread with [cane] plants, as the surest test of their ability, without reflecting, that extraordinary pains, bestowed on half the quantity, would yield an equal crop. Others wear out their lands by incessant cultivation, and a neglect of recruiting it with seasonable supplies of mould, or other dressing; and, after throwing it up, pass on to a new piece, which is destined to be worked to the bone in the same manner; and very few of them understand the method of preparing suitable compost for their land.

Unlike their counterparts in Barbados, who were early forced to apply fertilizer to their cane-lands, the planter of Jamaica took advantage of large areas of virgin land that cost little more than the clearing to grow canes until the fertility declined, and then shifted their labour force and other resources to open new lands in what may be described as a system of extensive sugar monoculture that was combined with a pastoral economy of some moment (Long 1774: I, 439-41; Sheridan 1974: 219-21).

Some efforts were made to reform the sugar plantation economy during the third quarter of the eighteenth century. The genesis of this movement is associated with growing absenteeism, for it was customary for planters to sit down on the eve of their departure for Europe and draw up written instructions for their managers and attorneys. Some of these instructions were later revised and expanded in the light of trial and error experiments and published as manuals that were sold to members of the plantocracy.

Samuel Martin, the leading planter of Antigua, was a case in point. For some years he and his family alternated between Antigua and England before he settled down in 1750 to improve the performance of his plantation and slaves. His *Essay Upon Plantership*, which was first written for the instruction of a young planter at an unknown date, went through seven editions and at least two reprints down to 1802. As I have told Martin's story as an innovating planter elsewhere, it is sufficient to say that he was a close student of Jethro Tull and other agricultural improvers in England and experimented with the ideas of writers on the "New Husbandry" on his *Greencastle* plantation. His efforts to improve his own plantations met with considerable success and his influence in the later years of his life (he died in 1777) was widespread (Sheridan 1960).

II

The period from 1775 to 1806 in the British West Indies was one of recurrent warfare, natural disasters, cost-price fluctuations, slave insurrections, pressure to reform and abolish the transatlantic slave trade and plantation slavery, and biological and mechanical innovations. Partly to counteract the propaganda of the abolitionists, partly to forestall slave revolts, and partly to restore their plantation profits after the destruction of wars and hurricanes, the more enlightened British planters looked for ways to reduce costs and raise revenues by means of managerial and technological innovation. They read the planter manuals written by Samuel Martin and other authorities and applied these ideas to their own estates. They formed agricultural societies which disseminated new ideas and the results of local experiments. As members of colonial legislatures, they received and acted upon petitions from local inventors seeking patents of monopoly, and they offered prizes to inventors of successful devices.

The Journals of the House of Assembly of Jamaica contain much information concerning improvements in the mechanical technology of the sugar industry. During the last quarter of the eighteenth century, when inventors and innovators were perhaps more active than in earlier or later periods, the Assembly received applications for patents of monopoly from 28 individuals, of whom 21 were designated by occupation, profession, or class. Professional men and skilled tradesmen consisted of two doctors, two millwrights, and one each of engineer, projector and engineer, carpenter, cabinet maker, mason, chemist, and mechanic. Additionally, there were five esquires, three planters, and two gentlemen. In a society of considerable occupational and social mobility, it was perhaps not unusual to find former artisans among the colonial gentry.²

Practically all phases of the technology concerned with crushing or milling, clarifying, curing, and distilling were allegedly improved by the inventors and innovators who sought patents of monopoly. For example, the inventions were variously described as a "new invented mill for grinding of sugar-canes", "an improved cattle mill for sugar estates", "an improvement on wheels for turning water-mills", "a hydraulic machine which raises water in any quantity", "a new method of hanging coppers for clarifying cane-liquor", "a method of greatly improving the manufacture of muscovado sugar and distillation of rum." In addition to sugar technology, several petitions described improved methods and machines for curing coffee beans and ginning cotton.³

The spread of the Industrial Revolution to the West Indies is evident from the number of petitioners who claimed to have successfully applied steam power to cane-crushing mills. Noel Deerr says "the first attempt to use steam power in the manufacturing process was made in Jamaica in 1768 at *Greenwich* plantation in the parish of St. Andrew". After the attempts to install old style Newcomen atmospheric or fire engines failed, the field was opened to improved engines manufactured by the British firms of Messrs. Boulton and Watt and Messrs. Fawcett, Preston and Company. These two firms supplied Jamaica with 65 cane mill engines from 1802 to 1852. Barbados, on the other hand, did not receive the first steam engine to power cane crushing mills until 1846; at that time the island had 506 windmills (Deerr 1949-50: II, 552-3; Deerr & Brooks 1940-1; Watts 1987: 405-25).

Contemporary authorities found little to praise and much to condemn in the conduct of field operations by Jamaican planters. Although Edward Long was encouraged by a "spirit of experiment" which had of late appeared, he nevertheless found "vast room for improvement". One difficulty was by reason of the great variety of soils and diversity of climate, one system of management that was successful in one part of the island was "utterly improper, and extremely detrimental in another". In explaining why no trial had been made of the "soft unctuous marle" which was plentiful in Jamaica, Edwards believed it was because the planters in general had no leisure for experiments, and that it was "difficult to make agents and servants (who have every thing to risk, and nothing to gain) walk out of the sure and beaten track of daily practice. Every man's experience confirms this observation." (Long 1774: I, 435-45; Beckford 1790: II, 193-7; Edwards 1793: II, 212-5).

Hoe culture on the sugar plantations appears to have been incongruous in an age when progressive farmers in England were following the practices outlined in Jethro Tull's *The Horse-Hoe Husbandry*. Samuel Martin wrote

that infinite hand labour could be saved by use of the Kentish hoe-plough in weeding canes, but he found by experience that stiff or heavy clay soils required more strength of cattle and horses to draw ploughs than the small pastures of the Eastern Caribbean islands could sustain. Long argued that "because no work on a plantation is so severe and so detrimental to them [field slaves] as that of holing, or turning up ground in trenches with their hoes, planters should adopt the plough not only to save the labour of a great many slaves, but also to cultivate more ground every year and produce sugar of superior quality". Indeed, Long asserted that in Jamaica "one plough turned up so much ground in one day, and in a much better manner, than 100 Negroes could perform with their hoes in the same time", the plough land yielding 3 hogsheads per acre, the same hoed 2 hogsheads. Edwards said that the plough had been introduced into Jamaica of late years and in some cases to great advantage, however, it was not practicable in every soil or situation. He maintained that the only advantageous system of ploughing in the West Indies was to confine it to the simple operation of holing, but that this operation could be performed with much greater facility and dispatch if the stiff and dry soils were first turned over with animal-drawn ploughs. John Davy, M.D., who lived in Barbados in the 1840s⁴, observed that prior to the abolition of the slave trade in 1808, the hoe was almost the only tool employed in cane or other cultivation. After abolition, however, planters apprehended a deficiency of labourers and introduced the plough and harrow. In Barbados, the success of implemental husbandry was marked and encouraging until the arrival of drought and short crops in the decade of the 1820s, when "the plough fell into disuse, and the exclusive hoe was resumed" (Martin 1802: 60-2; Long 1774: I, 448-51; Edwards 1793: II, 204-7; Davy 1854: 113).

Modern writers contend that the labour-intensive system of hoe culture, while it was unnecessarily wasteful of labour, was considered necessary by the sugar planters as a means of social control. The chief reason why planters felt it was unnecessary to change from the hoe to the plough, according to Richard Pares (1960: 23), was that the planter had labour to waste during more than half of the year. I have written elsewhere that while it was feasible from a technical and economic standpoint to use horse-drawn ploughs and harrows, actually such a move would have unbalanced the labour force. Planters, therefore, generally owned enough slaves to perform peak load tasks at crop time. They considered it dangerous to public order to idle a large proportion of their labour force during the so-called "dead-season" (Sheridan 1960: 139; Goveia 1965: 116-21).

Although implemental husbandry had little impact on the conduct of

field work in the slavery era, a biological innovation that affected both field and factory operations in important ways was introduced into the British sugar colonies in the early 1790s. This was the Otaheite or Bourbon variety of cane which was brought from the South Seas to the French West Indies in 1789, and to St. Vincent and Jamaica in 1793. This new variety of cane, according to Baron von Humboldt, was "one of the most important acquisitions for which colonial agriculture is indebted to the travels of naturalists." He said it yielded not only one-third more juice, but it was also thicker than the old "Creole" cane and the bagasse supplied more fuel to the boiling house. It was less vulnerable to dry weather and insect pests, but, on the other hand, it exhausted the soil more rapidly and did not ratoon as well as Creole cane. Planters were quick to introduce the new canes and the resulting bumper crops probably contributed to the severity of the price decline at the end of the century (Von Humboldt 1851: I, 486; Starkey 1939: 103-9; Deerr 1949-50: I, 20-1; Bennett 1958: 7, 103).

Pares (1960: 24, 69) has observed that sugar was more heavily capitalized than any other plantation industry, and that by far the greatest capital items were the value of the slaves and the acreage planted in canes by their previous labour. He noted that "with the mill, the boiling house, and the still went an army of specialists - almost all of them slave, but none the less specialists for that. They were not only numerous because of their skill, but had a high value." The shift from the employment of white to black tradesman on the sugar plantations was apparently completed during the middle decades of the eighteenth century. Extant inventories of plantation slaves seem to bear out this generalization. Of the 301 slaves on the Codrington plantations of Barbados in 1775, 21 of the men were classed as artisans. There were 3 coopers, 3 potters, 3 clarifiers, 3 distillers, 2 millmen, 2 blacksmiths, 2 basketmakers, 1 carpenter, 1 boiler, and 1 clayer. Bennett (1958: 12, 15-20, 73) writes that "craftsmen, head watchmen, head carters, and skilled workers ranked with the drivers of the great gang as the chief men of the Negro community. Their importance to estates was marked by many tokens of special status." William Dickson (1789: 26), who was secretary to the governor of Barbados in the 1770s and 1780s, noted that "so many blacks are now bred to all kinds of trades that the poor white artificers often find it difficult to get bread".

Jamaica followed Barbados in the shift from white to black skilled labour. In the early decades of the sugar industry white artisans were occasionally supplanted by their mulatto and black apprentices. In time, the planters who formerly depended upon white tradesmen found it was less costly

to train intelligent young slaves as skilled craftsmen. "They take the hoe, the adze, the hammer, or the plane the first time into their hands with as much youthful vanity as a boy at school does his bat; and it is not long before they know how to make an ingenious use of either", wrote William Beckford, the Jamaican planter historian (Beckford 1788: 14; Galenson 1981: 128-39; Craton & Walvin 1970: 102-5, 111, 138-40).

"Of the sugar colonies", writes Barry Higman, "only Barbados experienced an absolute increase in its slave population over the period 1807-34," when it rose from approximately 75,000 to 83,150. It was also remarkable that the island more than doubled its sugar production in the same period, and that the islanders were able to feed themselves to a large extent from local resources. William Dickson lived in Barbados during the transition from negative to positive net population growth. In his *Mitigation of Slavery*, he enumerated eleven reasons why the condition of the slaves was "less intolerable in Barbados, than in the other sugar colonies". Dickson argued that improved conditions prevailed in such areas as religious instruction, punishment, food supply and diet, and work loads. He noted that "in that island, the raising of provisions, for its unequalled population, is a prime object, not only with the ten-acre-men, and the white militia tenants, but with many or most of the sugar planters; and fishing is pursued with industry and success." Imported foodstuffs having been precarious during wartime and locally-grown provisions frequently inadequate, famine conditions were experienced on several occasions from about 1775 to 1807. "After the closing of the African slave trade in 1808", writes Bennett (1958: 101), "the newly formed agricultural associations brought home the lesson that the planters could no longer afford to lose Negroes to famine. When trade with the United States was almost cut off during the Napoleonic Wars, the Barbadians were prepared for the emergency" (Dickson 1969: 439-41; Watson 1975: 127-59; also Higman 1984: 50, 75, 205-14, 417-8).

Jamaica's sugar and slave experience differed greatly from that of Barbados in the half-century prior to slave emancipation in 1834. Jamaica's economy was more diversified than that of Barbados; its plantation economy grew much more rapidly than that of its sister island, especially in the period from 1784 to 1815; the profits of sugar production enabled a larger proportion of its proprietors to be absent from the island; and the planter elite came to be recruited chiefly from the ranks of overseers, managers, and attorneys. Jamaica's plantation economy continued to be less labour- and capital-intensive than that of Barbados. Whereas the ratio of slaves to acres of cane harvested was very near 2:1 in Barbados, it was approximately 1:1 in Jamaica where cane growing was less dependent

upon heavy manuring and ratoons supplied a larger proportion of the harvested canes. However, some evidence can be adduced to support a contrary conclusion with respect to labour intensity. Night work during crop time continued to be common in Jamaica down to emancipation, whereas it was largely discontinued in Barbados. Moreover, Barry Higman has estimated that the typical Barbadian slave worked an average of 3,200 hours annually, compared with 4,000 hours for his or her Jamaican counterpart (Higman 1984: 54, 112, 182-8; Barrett 1965: 165-7).

In summing up the slavery era, it appears that slave labour was generally compatible with technological progress, particularly in its mechanical aspects. By taking over skilled plantation tasks which were initially performed by white artisans, the black slaves demonstrated a high degree of adaptability to changing sugar technology. Such slaves, known as "privileged slaves", were commonly allowed small perquisites by their masters. On the other hand, it is true to say that the mass of slaves were generally kept in as degraded a condition of ignorance and poverty as possible. Yet, even here, as Douglas Hall overserves, "with the aid of small and relatively cheap assessories they could work on a wide range of tasks and materials, turning the soil, weeding, cutting canes, feeding the sugar mills, packing sugar, driving cattle or building or repairing roads, mills and houses". The versatility of the mass of slaves helps to explain "the generally slow and unwilling introduction of agricultural implements, such as the plough and harrow, during slavery" (Hall 1962: 305-18). Apart from implemental husbandry, Barbados planters and slaves moved more rapidly into biological innovations and less rapidly into mechanical innovations than their counterparts in Jamaica, especially in the period from about 1775 to 1834.

III

The slave emancipation bill was introduced into the House of Commons in May, 1833, chiefly because the abolition of the slave trade in 1808 had failed to mitigate the cruelties of slavery. Conflicts between contending interests in Westminster and the colonies had escalated into slave uprisings in Barbados, British Guiana, and Jamaica. "It was the Jamaican rebellion", writes William A. Green, "not the new vigour of the anti-slavery movement, that proved the decisive factor in precipitating emancipation." In brief, the emancipation act made the ex-slaves into apprentices to their old masters, who were required to supply them with allowances of food,

clothing, lodging, and medical attendance. In return for their subsistence, the apprentices had to give about forty-five hours of unpaid labour each week. After meeting this requirement, they were free to work for wages. Stipendiary magistrates were employed as guardians of public order and to ensure that the apprentices obtained their legal rights. Slaveowners, both resident and absentee, were awarded compensations for the loss of their slave property to the aggregate amount of £ 20,000,000 sterling (Green 1976: 111-27; Turner 1982: 148-78; Beckles 1984: 86-120).

Hoping to prove that free labour could produce tropical staples at a lower cost and with greater efficiency than slave labour, proponents of the apprenticeship system regarded the survival of the plantation with its purportedly cohesive, stable, and orderly environment as a necessary means to their goal of a free labour colonial system. Among other things, the apprenticeship period would enable the planters to "introduce new equipment, to experiment with new techniques, and to revise methods of labour management". Reality, however, fell far short of the grand scheme that was envisaged, for planters were prone to cling to arbitrary powers over their blacks, who were accused of behavior that was insolent, negligent, and disobedient. "In spite of its defects", writes Green, "apprenticeship did produce better working conditions and a moderation of discipline for the labouring people, and it offered the planters a valuable cushion between slavery and full freedom. In all respects, however, the system failed to establish the firm foundation of a free society which its proponents had intended" (Green 1976: 126-7, 130-8; Green 1973: 448-73; Levy 1980: 38-70).

Barbados entered the period of free labour in 1838 with a monocrop sugar plantation economy, rigid colour and class stratification, economic and political dependence on the metropolis, a largely resident planter elite, a high population to land ratio of approximately 700 persons per square mile. The transition from apprenticeship to freedom was marked by tension between whites and blacks over such issues as wage rates, ownership of cottages and gardens, vagrancy, and labour contracts. Workers who refused to work on terms dictated by their former masters were threatened with eviction. After several weeks of turmoil and idleness the workers generally returned to labour on their home estates. While the avoidance of coercion and the need to earn money to buy bread were immediate motives for returning to labour in the canefields and sugar mills, a longer-term solution was found in what is called the wage-rent or located labour system. It supplied the freedman with the security of his cottage and garden for his agreeing to give labour to the plantation upon which he resided when required. If he failed to appear for work or otherwise gave unsatisfactory

service, he was given notice of eviction by the owner of the property, and if he refused to leave he was subject to arrest. This paternalistic and quasi-feudal system of tied workers and cottagers and compensating advantages to these workers continued with some modification down to the decade of the 1930s; it supplied the plantation owners with a cadre of low cost and combined and continuous labourers (Levy 1980: 72-9; Starkey 1939: 117-8).

The change in land use was most significant in the reorganization of agriculture in Barbados, according to William Green. Although the freedmen continued to hold gardens or cottage plots after emancipation, they seldom grew enough food for their subsistence and they no longer received rationed allowances from estate owners. Thus, they must work for wages and buy food which more and more came to be imported from the United States. "By the fifties", writes Green, "well over half the total acreage in the island was committed to sugar, and even the working people preferred to use their small cottage plots for growing the cash crop." As the acres planted in provision crops declined, those used to grow sugarcanes increased. From the statistics of British sugar imports from Barbados which accounted for all but a tiny fraction of the island's total exports before 1860, we find that the early years of full emancipation witnessed a severe decline in sugar output owing to drought and labour unrest. Production and exports recovered slowly from 1841 to 1845, expanded more rapidly from 1846 to 1850, experienced a growth spurt from 1851 to 1855, and levelled off from 1856 to 1860. Sugar exports to Great Britain, which amounted to an annual average of 15,992 tons in 1841-45, increased so rapidly that by 1856-60 they were 32,087 tons annually, or double the exports of 1841-45 (Green 1976: 199-207; Deerr 1949-50: I, 193-4).

It is difficult to gauge the profitability of sugar production in Barbados, owing partly to fluctuations in the price of the staple in British markets, and partly to uncertainty regarding the cost of production in the island. Governor Sir Francis Hincks (1856-62) believed the average cost had declined since emancipation, chiefly from a reduction in labourers' wages, and that the planters enjoyed relatively high profits. According to Claude Levy, "Hincks explained that the abolition of slavery had materially benefited the planters, because the expense of paying wages to each person actively at work in the fields and mills was less than that of providing every Negro with food, clothing, and shelter, regardless of whether such individuals were able to contribute any useful work." Of a contrary opinion was Henry Taylor, Senior Clerk in the West India Department of the Colonial Office, who, in reviewing Hinck's dispatches to London, "was unable to agree that intensified production had benefited the proprietors in proportion to their efforts (Levy 1980: 124-6).

What does seem certain is that, in consequence of the Sugar Duties Act of 1836, which called for reduction and eventual elimination of the differential duties favouring the colonial product, the planters of Barbados felt that dire necessity compelled certain changes. Wages and salaries were greatly reduced, numerous proprietors took upon themselves the management of their own estates, and, as Davy explained, "a more economical system throughout was adopted with a great reduction of expenditure, even in some instances, to the amount of 40 percent." Davy expressed the hope that the crisis of 1847-48 would generate positive action and lead to a salutary and eventually beneficial outcome. He noted "a growing disposition to view agriculture more in the light of a science, and to consider the making of sugar more as a chemical process to be directed by science". One biological innovation was the system of "wide planting", whereby the distance between the rows was increased from three or four to six or eight feet, "and with marked improvement in the size, vigor, health, and yield of the cane". Planters experimented with new types of fertilizers. Whereas pen manure with mould had been used almost exclusively in earlier years, now experiments were conducted with Peruvian guano, nitrate of soda, soot, and imported manures. Guano was first applied to the canefields in 1846, and by the mid-fifties the Barbados planters led all others in the use of this bird dung which was imported to the average value of £ 50,000 a year. Trashing or mulching the growing cane plants with leaves obtained from the former crop was more widely practiced for the purpose of retaining moisture in the soil, checking the growth of weeds, and promoting the growth of canes. By paying the worker by the job or task, such as weeding a cane piece, it was said that he or she could complete in six hours the amount of work that had formerly required twelve hours for a slave (Davy 1854: 115-6, 142-4; Green 1976: 202; Sewell 1861 51).

Implemental tillage came to supplement and in some cases supplant cane hole agriculture in Barbados. Owing to ample supplies of cheap labour to perpetuate their garden-type cultivation, Barbadian planters were slow to introduce animal-drawn instruments of husbandry. Davy said the use of the plough was not resumed until 1839-40, and then only partially. By the early 1850s he said it was still far from being generally in use. Later in the same decade William Sewell, the New York journalist, found on his visit that the Barbadians, after long hesitation, had at length introduced the plough, "though some few fogies, as fossiliferous as their own rock, still question the safety of the innovation" (Davy 1854: 114; Sewell 1861: 59).

Although Barbados was in the vanguard in adopting the new biological

technology, it lagged behind the other sugar colonies in introducing mechanical technology. The Barbadians were slow to substitute steam engines and improved mills for windmills, for we have seen that as late as 1846 there were 506 windmills and only one steam mill. This state of affairs was investigated by the Committee on Sugar and Coffee Planting in the Colonies. George Carrington, an absentee proprietor who had returned from the island one year previous testified in March 1848, that there were three or four steam-mills in Barbados. He told of having recently sent out a horizontal steam-mill for grinding the canes on his own plantation. His goal was to shorten the crop time, guard against the uncertainty of the wind, and realize considerable saving by being able to reap his crop precisely when it came to maturity. Unfortunately, and for reasons he did not reveal, Carrington "incurred the expence of upwards of a thousand pounds in effecting that which I now feel may be entirely thrown away". Anthony Trollope noted on his visit to the West Indies in 1859-60, that in Barbados "not one planter in five, not one I believe in fifteen, has any steam appliance on his estate. They trust to the wind for their motive power, as did their great-great-grand-fathers."⁵

Besides the cane crushing mills, the boiling and curing houses of Barbados were the scene of experiments with the new sugar technology. Dr. Davy (1854: 144-6) wrote with enthusiasm of the installation of vacuum pans, Gasden-pans, precipitators, and centrifugal dessicators which he claimed were coming rapidly into fashion. At the time of writing in the early 1850s, he said that four vacuum pans had been installed in the island and that, under careful and skilled management, there had been a gain of 25 percent.

A project to construct a railway in Barbados was conceived in 1845 by a group of British promoters headed by Sir Robert Schomburgk. Although the chief revenue was expected from passenger traffic, the railway was intended to serve the needs of the plantations by providing cheaper and more expeditious transport than that of the animal-drawn vehicles in the carriage of sugar from the interior to the ports. The railway project failed because of the shortage of local capital and the unwillingness of the British government to make a loan to Barbados (Schomburgk 1848: 185-8, 527-8; Levy 1980: 100).

IV

The decline of Jamaica's sugar industry long antedated the freeing of the slaves. From the period of the American Revolution the planters were plagued with trade embargoes, hurricanes, droughts, threats of slave

insurrections, fluctuating costs and prices, and alternating periods of high and low profits and not infrequent losses. Abolition of the transatlantic slave trade foreclosed the customary means of maintaining or expanding the labour force and added to costs of staple production. The high point of sugar production was in the quinquennium 1801-05, when an annual average of 86,640 tons of sugar was imported into the British Isles from Jamaica. By 1831-35, the imports had declined to 65,896 tons annually, after which they fell precipitously to 22,943 tons in 1856-60, or by nearly two-thirds of the 1831-35 figure. Based on raw sugar prices in London, the annual average value of sugar imports from Jamaica was £ 1,910,984 sterling in 1831-35, and £ 620,703 in 1856-60. The most remarkable thing is that while the sugar imports from Jamaica exceeded those from Barbados by nearly 50,000 tons annually in 1831-35, by the early 1850s the imports from Barbados had overtaken those from Jamaica and were approximately 9,000 tons greater annually in the 1856-60 period. Jamaica's exports of rum and coffee, of which the United States and Canadian markets took off considerable quantities, declined in roughly the same proportions as that of sugar (Deerr 1949-50: I, 193-9; II, 531; Hall 1959: 39).

Numerous writers sought to explain the decline of Jamaica's sugar industry. Looking back from his vantage point in the early twentieth century, Lord Olivier (1971: 131) believed that "[t]he most obvious causes that undermined the old sugar economy and hindered its readjustment to the new conditions were absenteeism, reactionary overseers, obsolete technical methods, the excessive burden of mortgages, profligate soil exhaustion, the attempt to coerce labour at low wages by unfair rents, and access by labourers to unoccupied land", John Bigelow (1851: 79-82), the American journalist who visited Jamaica in 1850, was informed that nine-tenths of the land under cultivation before the Emancipation Act was owned by absentee proprietors and that that proportion had not diminished materially. He asserted that it was the tendency of absenteeism "to drive from a country its intelligence, its ingenuity, and its patriotism". To W.G. Sewell (1861: 237, 276), absenteeism was "the most prominent among a host of evils", since it exhausted capital, destroyed credit, and led to the abandonment of many sugar estates.

Absenteeism and mortgage debt went hand in hand. In former periods of prosperity and buoyant optimism absentees had borrowed money on the security of their estates to support extravagant lifestyles and provide annuities and marriage portions for family members. Subsequent periods of declining prices and profits found the estates to be mortgaged for more than they were worth. John Bigelow discovered "from the most authentic and reliable sources" that there was "scarcely an estate upon the island

which is not mortgaged, or which has not been sold under a mortgage sale". The heavy debt burden, in turn, left Jamaican planters and agents with little or no means or capital to carry on the cultivation and manufacture of sugar (Bigelow 1851: 113-4). To the Jamaican planter the chief cause of decline was the high cost and uncertain supply of labour. Planters told W.G. Sewell that the emancipated blacks were "too independent, too well off here – too fickle, arbitrary, and uncertain as to when they will work and when they will not work. They just do as they please." The planters insisted that the black would not work longer than was necessary to supply his meagre standard of living. The blacks, on the other hand, complained that the planters were too poor to pay, or that they did not pay regularly. Actually, the typical freedman aspired to a higher standard of living than had prevailed in slave days. He was attracted to the considerable tracts of idle estate land that were available for as little as £ 4 to £ 10 an acre, but he was willing to work for wages on the estates for three or four days a week in order to provide the means to vary his family's diet with imported foodstuffs and to buy clothing and other consumer goods (Sewell 1861: 186, 193; Eisner 1961: 191-5, 210-6; Hall 1959: 15-20; Marshall 1968: 252-63).

Planters sought to retain labourers on their estates by charging high rents for the use of huts and provision grounds and by discouraging the sale of idle land to the freedmen. However, in the face of the exodus of labourers from the estates, the planters found it necessary to retreat from their aggressive policies. Due partly to some progress in resolving disputes regarding wages and rents, partly to schemes for immigrant labour, and partly to the introduction of labour-saving innovations, the sugar industry of Jamaica experienced considerable advance from the early 1840s until 1846. According to Douglas Hall, the reduction of the agricultural labour force induced planters "to attempt to maintain the volume of production by substituting animal and mechanical power for human effort, and to increase productivity of the remaining labourers". Although capital and credit were severely limited, a few planters benefited from the relatively high sugar prices from 1836 to 1842, and a larger number received slave compensation money which generally improved their credit standing in Britain, at the same time that it was swallowed up in debt repayment (Hall 1959).

Full emancipation in 1838 saw heightened interest in scientific agriculture and the adoption of biological and mechanical innovations. The Royal Agricultural Society of Jamaica, together with similar societies in separate parishes, held agricultural fairs and exchanged information on such subjects as soil chemistry, fertilizers, implemental husbandry, animal husbandry,

cane diseases and pests, and successful innovations in manufacturing processes. Ploughs, harrows, and horse-hoes were widely adopted, especially on level cane fields that were free of obstructions and possessed of light soils. Local craftsmen developed rugged and deep-cutting instruments that were adapted to heavy and compact soils. These animal-drawn implements enabled cane rows to be spaced more widely and made weeding easier. From his study of the various contemporary reports on the use of the plough and harrow, Hall calculates that these implements reduced the labour costs of planting and cultivation per acre by about 65 percent. To increase the yield of the cane fields, cattle manure was supplemented by such island fertilizers as lime, ashes and seaweed, and such imported fertilizers as bone-dust and especially guano (Hall 1959: 27-32, 46-50, 57, 63, 66; Green 1976: 52-4, 199-200).

The period of optimism in the post-emancipation period saw the adoption of improved mechanical technology. Cane crushing mills gained power and certainty by the substitution of steam power and water power for cattle and wind. Hall says that although the small steam-powered mill did not appear to have any great advantage over a well-built water mill with a dependable flow of water, "both these types were immeasurably superior to wind mills and far better than animal mills". "By 1854", he writes, "just over two-thirds of all sugar mills in the island were driven by steam or water, and just under one-third by steam. This is clear evidence of widespread attempts to improve manufacturing methods." Although small improvements were made in the boiling and curing of the cane juice, such new technology as the vacuum pan was so costly and the labour supply so uncertain that only three estates had installed this equipment by the mid-century period (Hall 1959: 69-76).

Transportation and central factory projects were launched to bridge the gap between cultivating and processing to amalgamate estates and have one large factory serve a whole cane-growing area. While the South Midland Railway and the Clarendon Tramway projects failed to materialize, the thirteen miles long railway from Kingston to Spanish Town was opened in November 1845. In the following year two proposals were put forward to establish central sugar factories, but they failed to materialize (Hall 1959: 35, 38-40, 59-60, 85-93; Eisner 1961: 198-200).

The Sugar Duties Act of 1846 served as a watershed between the period of optimism and innovation and that of pessimism and retrenchment. In the new climate of pessimism and retrenchment, the new sugar technology was found to be less widely adopted than was formerly thought and its merits and demerits more soberly assessed. Bigelow asserted that there

was an "entire neglect of the most obvious methods of economizing labor", while Sewell claimed that the typical Jamaican planter practically ignored all the agricultural and mechanical improvements of the century. Ploughs and harrows were reported to have improved the system of cultivation generally, but they were far less widely adopted than was formerly thought, they required large numbers of draft animals to work them, they were frequently broken on the rocks and rendered useless for want of tradesmen to repair them, and they were costly to operate by ploughmen who were brought out from Europe. Hall Pringle, a Jamaican planter, claimed that very few planters and their hired managers knew anything of the art of ploughing. "White ploughmen in most cases met with a speedy death from fevers, the consequence of their employment under a tropical sun", he wrote. "It was found, however, that the negroes could be very soon converted into expert ploughmen. Nevertheless, this slight improvement in West Indian agriculture made scarcely any progress, and for the most part the use of the plough was abandoned in Jamaica; though the plough has continued to be employed in some other West Indian colonies with great success" (Bigelow 1851: 129-37; Sewell 1861: 274-5; Pringle 1869: 14-5).

Jamaican planters claimed that they were avidly interested in scientific agriculture and said that special attention was given to experiments with imported fertilizer, notably guano. Yet, they were slow to exploit a source of this bird dung that was close to hand and much cheaper than far distant supplies. Rich deposits of rock guano were discovered on the Morant and Pedro Cays, lying thirty to fifty miles south of Jamaica and governed from that Colony. They were first exploited by North Americans and much later by Jamaicans (Green 1976: 199-200; Beachey 1957: 88).

Improved machinery for the sugar works was not only expensive and difficult to procure in a period of capital and credit stringency, but there was an acute shortage of first-class tradesmen to install, operate, and repair the machinery. The establishment of central factories presented insurmountable difficulties after 1846, including lack of cooperation among proprietors and their creditors, limited areas where sufficient level land was available, lack of cane farmers to grow canes for the factory on a contract basis, and the heavy mortgage indebtedness and claims by annuitants on the annual revenue of plantations. Similar problems were encountered in building light-gauge railways or tramways in Jamaica.⁶

Jamaica's labour problems worsened after 1846, chiefly because the planters found it increasingly difficult to offset the freedmen's attraction to independent settlement by offering sufficiently high wages and other favourable conditions of employment. Planters complained that the freed-

men were too independent to work for wages or that they refused to work more than five to six hours a day and four to five days in the week. Moreover, at critical seasons, the freedmen were charged with leaving an estate almost deserted to plant or look after their own provision grounds. The freedmen, on the other hand, complained that the planters would not give continuous work at continuous wages, and that they were too poor to pay or that they frequently delayed wage payments. Given the labour problems, limited gains in productivity, heavy debts, and absenteeism, it became obvious that many plantations could not hope to continue in production. The number of sugar plantations in Jamaica reached a peak of 859 in 1804. Thereafter, they declined to 646 in 1834, 513 in 1846, 330 in 1854, and 300 in 1865. Between 1834 and 1865 some 346 sugar estates were abandoned. Gisela Eisner says that "many of them were uneconomic in the sense that they had been profitable only as long as labour mobility could be restricted, and hence wages controlled." As the number of sugar estates declined, the number of black peasants increased. The estimated number of peasants, that is, freedmen who held some land either as purchasers or squatters, increased from at least 30,000 in 1846 to 50,000 in 1860, and to 60,000 in 1866 (Sewell 1861: 186, 279-4; Hall 1959: 81-3; Eisner 1961: 203, 215-6).

V

British West Indian planters and labourers were confronted with a host of problems in the years from 1860 to 1900. Jamaicans were especially hard hit at the beginning of the period by poor crops, low and irregular wages, and the high cost of imported foodstuffs during the American Civil War. Peasant discontent escalated into an outbreak of disorder and bloodshed at Morant Bay, Jamaica, in October 1865. British sugar planters met with growing competition in United Kingdom markets, especially beginning in 1874 when sugar duties were completely removed. The situation worsened as European nations dumped more and more bounty-fed beet sugar into United Kingdom markets. The price of sugar declined below the cost of production on many estates, resulting in genuine distress. At a time when London sugar prices were plummeting, those prevailing in the United States and Canada fell less severely and attracted increasing quantities of sugar and other products from the British Caribbean colonies. Notwithstanding the growth of alternative markets, the sugar industry was in such dire straits that in 1897 a Royal Commission was appointed "to enquire into the conditions and prospects of the sugar-growing Colonies

in the West Indies and to suggest means calculated to restore and maintain the prosperity of those Colonies". We shall see that the Commissioners found that the economies and societies of Barbados and Jamaica were following divergent paths, the former continuing to concentrate practically all of its resources on the production of sugar and its by-products, while the latter was in the process of shifting the greater part of its resources to the production of subsistence crops and agricultural staples other than sugar.⁷

Noel Deerr has tabulated the West Indian sugar production of the different colonies to demonstrate the overall effects of emancipation and of the adoption at a later period of free trade. Table 2 shows the contrasting change over time of sugar production in Barbados and Jamaica.

TABLE 2: AVERAGE ANNUAL SUGAR PRODUCTION OF BARBADOS AND JAMAICA, 1824-1896
(in tons)

	1824-33	1834-38	1839-46	1847-56	1857-66	1867-76	1877-86	1887-96
Barbados	14,838	20,309	15,652	28,622	36,367	40,358	46,260	54,667
Jamaica	68,465	54,225	33,431	27,474	25,168	25,666	21,571	20,891

Source: Deerr, 1949-50: II, 377.

If we compare the 1847-56 period with that of 1887-96 in Table 2, we see that while the sugar production of Barbados nearly doubled, that of Jamaica declined by nearly one-fourth. Barbados' extreme sugar monoculture is demonstrated by a table in the Royal Commission Report which shows that the collective export value of sugar, rum and molasses from that island was 98.0 percent of total export value in the 1887-96 period. Another table shows that while the share of the island's total exports to the United Kingdom declined from 50.7 to 5.8 percent from 1887 to 1896, the United States' share increased from 22.3 to 70.8, and that of Canada and other countries declined from 27.0 to 23.4 percent in the same period. On the other hand, Jamaica's collective value of sugar, rum and molasses exports declined from 77.2 percent of total exports in 1881-82 to 19.2 in 1895-1896.

The island's share of total exports to the United Kingdom declined from 60.2 to 13.8 percent from 1881-82 to 1895-96. In the same period the exports to Canada and other countries declined from 31.5 to 3.8 percent, while those to the United States increased from 8.3 to 82.4 percent.⁸

The sugar economy of Barbados was thoroughly investigated by the Royal Commission during its stay on the island from 16 to 24 February,

1897. "In Barbados there is substantially but one industry, one product, and one export – that of sugar – nor does the Island appear to be suited for the growth of either coffee, cocoa, or fruit on a scale of any commercial importance", said the Report of the Commission. At the time of the visit Barbados had an estimated population of 186,000, giving a density of 1,120 to the square mile, compared with the 1844 population of 122,200 and density of 740 persons per square mile. The number of sugar plantations, which had been relatively stable at about 500 from 1860 to 1890, declined to 440 in 1897. The average size of plantations increased from 179 acres in 1860 to 206.5 acres in 1897. In the latter year there were 23 plantations over 500 acres, 175 from 201 to 500, 103 from 101 to 200, and 138 less than 100 acres. The acreage in cane remained constant at roughly 90,800 acres from 1890 to 1897. In the latter year muscovado sugar was produced on 94 percent of the plantations and centrifugal sugar on the remaining 6 percent.⁹

Innovations in biological technology played a part in saving the sugar industry of Barbados and other sugar colonies from possible destruction. Beginning in 1891, the yield of the Otaheite or Bourbon experienced rapid decline as the result of a fungus disease. Fortunately, as R.W. Beachey points out, the Government of Barbados had appointed an agricultural chemist, who, with the assistance of his colleague and the cooperation of the local agricultural society, did much to prevent the spread of the disease and to introduce new varieties. By 1897, following the development of a new variety called White Transparent, the planters of Barbados had the cane disease under control. Other experiments were conducted on the effect of fertilizers – both farmyard and artificial – on the yield of sugarcanes. Barbadian planters took advantage of the great reduction in the price of imported fertilizers, especially sulphate of ammonia, to apply them in greater quantities, with a reported increase in crop production of 15 percent in the decade ending in 1897. On the other hand, there was no innovation of modern tillage introduced on the sugar estates of the British West Indies during the second half of the century and the plough was still rarely used (Beachey 1957: 89, 92-3; Starkey 1939: 124-6, 153-6; Hoyos 1978: 173-6).

Improvements in the manufacture of sugar were not extensive during the later decades of the nineteenth century. When the Royal Commission enquired about recent improvements in the production of sugar, the Joint Committee of the Agricultural Society and Mercantile Body of Barbados replied in a written communication that "steam machinery has during the last 30 years been more extensively employed for crushing, and has no doubt effected some considerable saving by reason of the greater

reliability of its operation as compared with wind power." From 30 steam mills in 1866, the number increased to 49 in 1875, 90 in 1884, and 102 in 1896. The number of windmills in 1896 was about 338. "Eight plantations, aggregating some 5,000 acres, have vacuum pans, but these were all erected prior to 1884," said the Committee Report. Owing to the imperfect crushing of the canes in the mills, it was stated that 13.6 tons of cane were required to produce one ton of sugar in Barbados, whereas the best machinery would require only 9.5 tons of cane to one ton of sugar. Similarly, imperfect boiling and curing of the cane juice resulted in a substantial loss in the amount of muscovado sugar that was recovered.¹⁰

Among the numerous reasons for the failure to modernize the Barbadian sugar industry, two are of paramount importance. The severe decline in sugar prices beginning in 1884 brought real hardships to the planters and their dependents. The Royal commission learned that while some estates in favourable situations and with favourable seasons might just make a profit at prevailing sugar prices, others were being worked at a loss. As a rule, the estates were very heavily mortgaged and it was increasingly difficult to get advances to carry on cultivation. In particular, it was difficult to raise money on the plantations for capital improvements. Although a large majority of the plantations were heavily encumbered, it was stated that these incumbrances had not diminished production or checked the expansion of the industry. On two occasions between 1884 and 1896, Barbadian planters attempted to secure government loans to build central factories. They were "turned down by the Colonial Office on the ground that they were unsound, considering the state of colonial finances, and that unless a first charge on the estate was given as security, the Colonial Government must not enter into such speculation. Estate owners were usually agreeable to giving this first charge, but mortgagees were not."¹¹

The generally prosperous state of the plantations down to the mid-1880s was the second paramount reason for not modernizing the island's sugar industry. The Royal Commission noted such special circumstances prevailing in Barbados as the more abundant and effective labour supply and a soil that was especially well suited for growing sugarcane with exceptionally rich juice. The Joint Committee of the Agricultural Society and Mercantile Body of Barbados stated that large factories had not been erected in former prosperous times because "the profits derived from muscovado sugar were so good that the proprietors of plantations were content, and had no motive arising from a felt necessity for adopting improved machinery."¹²

The Royal Commission enquired as to the conditions of labour, its cost and efficiency, access to provision grounds, cost of living, and related

matters. The Agricultural Society and Mercantile Body said that labour was plentiful, fairly efficient, supplied at a moderate cost, and that most operations were done by piece-work. Wages amounted to 5d. per day for children under 16, 7½d. for agricultural women, 10d. for agricultural men, and 2s. for mechanics. A great many women and children were said to be employed on the plantations. One planter was asked if there was any system by which mechanics could become efficient workmen. He replied: "The apprenticeship system is in a sadly decaying condition now. Formerly it was flourishing." Concerning the "peasant" sector of the Barbadian economy, it was reported that approximately 4,500 of the total acreage of the plantations was rented to agricultural labourers, but that few of them grew their own food. Additionally, there were about 8,500 freehold owners of five acres and under who chiefly grew cane and ground provisions. Since they seldom made a living out of their land alone, they were also self-employed as shopkeepers and artisans. The cost of living was said to be very small and food cheap.¹³

That the labouring people of Barbados bore the brunt of the sugar depression of the late nineteenth century is amply documented by the evidence submitted to the Royal Commission of 1897. The Reverend J.E. Payne, Wesleyan minister in the parish of St. Philip, considered the condition of labouring people to be "one of extremely great poverty, demoralising in its effects, and presenting very serious difficulties in the way of their moral advancement and enlightenment." To support this statement he called attention to their overcrowded, comfortless homes that were prejudicial to the maintenance of morality and sanitation; their food which consisted almost entirely of vegetable and was insufficient to maintain a working man in health and vigour; their children who were kept from school and church for want of clothing; their frequent and distressing appeals for charitable relief. Payne considered "that the wages obtained by the labouring people (from 2s 6d. to 5s. a week, out of which they have to pay the rent for the small plots of land on which their houses stand) are not sufficient for their maintenance." C.E. Gooding, M.D., a parochial medical officer, submitted evidence showing the increase of pauperism in Barbados of late years and the high and growing death rate. He said that many islanders found it "difficult to keep soul and body together at any time, but in periods of drought (to which our seaboard districts are very liable) the number of these is vastly increased, and their privations extreme". During the harvest season when work was at its height and the demand for labourers satisfied, "crowds of unemployed, both young and old, of both sexes, lounging from place to place, both in the city and country districts for want of employment", was the condition reported

by J.F. Clarke, M.D. Mr. T. Henri Field called attention to the deep feeling of unrest among the labouring population of Barbados and warned that any further reduction of the rate of wages would possibly precipitate social disorder.¹⁴

Jamaica's sugar industry, which continued to decline down to the outbreak of World War I, was unable to support the island's growing population. From approximately 371,000 at the time of slave emancipation in 1834, the population of Jamaica increased to 694,865 in 1896, or an increase of 87 percent, in a period of approximately sixty years. We have seen that the number of sugar estates in Jamaica declined from 646 in 1834 to 300 in 1865. Thereafter, the decline continued at an even more rapid rate.

There were 266 estates in 1869, 244 in 1875, 202 in 1880, 162 in 1890, 140 in 1896, 111 in 1900 and 74 in 1910. According to the Report of the Royal Commission of 1897-8, the area under cultivation in sugar cane in Jamaica in 1896 was 30,036 acres, equal to 16.4 percent of the land under crops in the colony, or to 34 percent of the land producing exportable crops. Of this average, 24,972 was cultivated by the workers on 140 sugar estates, and 5,064 by small settlers on their own properties. The majority of the estates were small (the average area in cane being only 178 acres) and they were also, for the most part, widely dispersed. Steam-power was employed on 95 estates, waterpower on 38, water and steam on 3, and cattle on 4. Of the 140 sugar estates, six had vacuum pans, and the rest were "worked with open batteries, assisted in the great majority of cases, by evaporating pans, of various kinds and centrifugal machines". Seventy percent of the estates produced centrifugal sugar; the other thirty, raw or muscovado. Rum was distilled on 98.5 percent of the estates. The average crop of sugar was 23,492 tons, and the average crop of rum was 20,448 puncheons of 100 gallons each.¹⁵

One measure of the slow progress that was made in modernizing the sugar industry is the average output of the sugar factories of Jamaica by comparison with those of British Guiana. In the period, 1880-1900, the number of factories in Jamaica declined from 202 to 111, while the average output in tons of sugar rose from 148 to 187. In British Guiana, the number of factories declined from 105 to 46 from 1885 to 1904, while in the same period the average putput rose from 914 to 2,320 tons of sugar. As late as 1930, the 39 factories in Jamaica had an output of only 1,572 tons. In contrast to Jamaican estates, those in British Guiana converted rapidly to multiple-effect evaporators after 1884 with a massive reduction in production costs. British Guiana also gained on Jamaica by drawing on much larger supplies of indentured immigrants from India (Eisner 1961: 302; Adamson 1972: 188-99).

Much of the reorganization of the sugar industry of Jamaica was undertaken by the West India merchants of London, of whom a considerable number became proprietors in their own right. These partnership firms had intimate knowledge of the island's sugar industry from their long established mercantile, shipping, and financial connections. They took advantage of the West India Encumbered Estates Court which was established in 1861, to make out an indisputable title to any would-be purchaser of West Indian estates which were heavily encumbered by charges placed on them in the heyday of the sugar industry. Beachey says that "the improvements that were made in Jamaica in the matter of installing centrifugals and open steam pans were mostly effected by the merchant firms who had acquired holdings through the Encumbered Estates Court". By 1897, 48 of the 140 sugar estates in Jamaica were equipped with centrifugal separators (Beachey 1957: 1-4, 6-8, 17, 36, 72-3, 123-4; Pringle 1869: 30; Eisner 1961: 202, 295-303).

Had it not been for the sustained demand and high price of the superior quality rum that was distilled in Jamaica, it is likely that the mortality of the sugar estates would have been higher than it actually was. Rum was produced on 138 out of the island's 140 estates in 1896. "By the end of the century", writes Beachey, "when sugar prices had dropped and the reputation and price of Jamaica rum remained high, it was held by Jamaican planters that sugar was but a by-product to the main industry of manufacturing rum".¹⁶

The Sugar Planters Association of Jamaica submitted written evidence to the Royal Commission regarding the state of the island's sugar industry. It was conceded that "the introduction of new machinery on some estates would assist in reducing the cost of production". However, the small estates, which were the rule in Jamaica, "could not afford even under favourable circumstances to employ the most perfect machinery and appliances. The outlay and small acreage of cane land would not justify it." Furthermore, the statement of the Planters Association said that "an amalgamation of estates in some districts might be possible, in which case the modern plant might be installed, and be warranted by a given acreage of cane land, and with proper management effect a considerable saving".¹⁷

The rise of the Jamaican peasantry is a fascinating story which merits a brief account of its progress down to 1900. Emancipation enabled freedmen to expand and diversify the production of their smallholdings which, in many cases, they had formerly cultivated as slave provision grounds. After about 1865, there emerged a "new peasantry" which shifted from mainly subsistence farming to both subsistence and export crop production, chiefly fruit crops. By the late decades of the nineteenth century

the fruits grown for export consisted of bananas, coconuts, oranges, grapefruit, shaddocks, tangerines, limes, pineapples, and tamarinds (Eisner 1961: 170, 210-217; Marshall 1968: 256-257; Pringle 1869: 26, 43-44).

The fruit trade between Jamaica and the United States commenced in 1868. It was first carried on by merchants in the coastal towns who dealt directly with peasant growers. By the 1880s companies had been organized, of which the great majority of the shareholders were small peasant proprietors, storekeepers, and artisans. "By the early 1890s", writes Hall, "there were more than one hundred banana plantations, distinct from small peasant cultivations. Many of these had once been sugar estates, but it was still the new proprietary body who dominated the new cultivation." The Royal Commission reported in 1897 that the fruit trade in Jamaica "is now the means of circulating nearly 500,000 £ annually amongst all classes of the community, and this large sum is immediately available in establishing other and more permanent industries".¹⁸

Furthermore, the Royal Commission noted that there were 30,036 acres under sugar cultivation in Jamaica; "but whereas most of the other Colonies are almost entirely dependent on sugar-cane, Jamaica produces besides coffee, logwood, bananas, oranges, pimento, ginger, cocoa, cocoanut, tobacco, and other articles of export, the value of which, as shown in the returns of 1895-96, amounted altogether to about 1,415,000 £, as against 360,059 £, the value of the exports of sugar, rum, and molasses".

Jamaica was therefore in a better position to meet the falling off in the sugar trade than any of the other West Indian Colonies, with the exception of Grenada which had abandoned sugar except for local consumption, and was supporting itself entirely by other products.¹⁹

The Royal Commissioners, in their Report of 1897-8, were impressed by the achievements and standard of living of the Jamaican peasants. After holding public sittings for five days, examining 63 witnesses, and visiting outlying parts of the island they concluded that "there was a tendency on the part of some witnesses to dwell on the depressed state of the Jamaica peasantry, but there is little doubt that the bulk of them are in a position which compares not unfavourably with that of the peasantry of most countries of the world". On the whole they found "no ground for despondence as to the future of Jamaica, either in view of the possible failure of the sugar industry or on general considerations, but it is most desirable that the settlement of the people on the land should be encouraged". During their stay in Barbados, the Commissioners interrogated the Reverend C.T. Oehler, a Moravian missionary who had lived in Jamaica and was then living in Barbados. He was asked if the condition of the people in Barbados was worse than it was in Jamaica. He replied, "I

think it is. Kingston is by no means as overcrowded as this town [Bridgetown], and the people of the country districts of Jamaica are better off than the people here, because they can get many things to eat free that cannot be obtained here except for money." He was asked, "What are the things found in Jamaica and other places fit for consumption?" He replied that nearly the year round mangoes and oranges could be found. Furthermore, he said, "In some districts in Jamaica almost any one can have a piece of land if he wishes it, and he can cultivate it for his own benefit. Here firewood has to be purchased, but in Jamaica it can be obtained only for the cost of gathering it."²⁰

VII

This article has examined the pattern and direction of technological change in the sugar industry of the islands of Barbados and Jamaica from 1750 to 1900, together with the impact of such change upon the slave and free workers engaged in the production of sugar, rum, and molasses. Since the typical plantation combined cane growing with the manufacture of muscovado sugar and rum, a distinction is made between biological technology by which plant and animal production was improved by increasing the effective supply of nutrients, and mechanical technology by which non-human power was substituted for human and animal power. It has been argued that in the slavery period Barbados developed a capital-intensive, power-intensive, and labour-intensive system of sugarcane agriculture and the manufacture of muscovado and clayed sugar and rum that was conducted on a sustained-yield basis. While the island's mechanical technology which was powered largely by windmills remained essentially unchanged, innovations in biological technology consisted chiefly of cane hole agriculture, heavy manuring, crop rotation, and the introduction of a new variety of sugarcane. Barbados was the only sugar colony which experienced an absolute increase in its slave population over the period 1807-34, during which time the island's sugar production more than doubled and the islanders were able to feed themselves to a large extent from local resources. Barbados was also in the vanguard in training specialist slaves to man the mills, boiling houses, curing houses, and distilleries on the estates.

Jamaican sugar planters in the slavery period practiced a land-intensive system of cane growing that, by comparison with Barbados, was less labour and capital-intensive and less dependent upon heavy applications of manure. A major biological innovation was the introduction of Guinea grass from

Africa which supported a pastoral economy which was to a large extent integrated into the sugar economy. Jamaicans were more prone to experiment with mechanical technology than their counterparts in Barbados, but little progress was made in substituting mechanical for human and animal power in the slavery era. Sugar slavery was generally harsher in Jamaica than in the older sugar colonies, partly because the slaves were expected to feed themselves from their provision grounds. As the slave population declined after 1807, the proportion of female field hands increased, but at a severe cost to the birth rate. Thus, the labour productivity of the sugar plantation was maintained at the expense of reproduction of the slave labour force.

After slave emancipation in 1838, the two islands followed divergent paths. Barbados continued on its monocultural path, again with emphasis upon biological technology to a much greater degree than such mechanical innovations as steam power, vacuum pans, and centrifuges. The biological innovations consisted of the wide planting of the rows of canes; heavy applications of local and imported fertilizers, especially guano; the trashing or mulching of the growing cane plants; and the development of new varieties of sugarcane. During the later decades of the century the plight of the sugar planters worsened as European nations dumped more and more bounty-fed sugar into United Kingdom markets. The Barbadian planters' efforts to compete took the form more of wage cuts than cost-saving technology. Unlike British Guiana and Trinidad where the competition of imported contract labourers forced the freedmen to work harder and for less money, in Barbados access to land and other local resources was largely shut off so that the freedmen were prevented from developing alternative source of livelihood. "In effect", writes Sidney Mintz, "the planter class sought to re-create pre-emancipation conditions - to replace the discipline of slavery with the discipline of hunger" (Mintz 1968: 70).

Jamaica's sugar industry declined dramatically from 1834 to 1900, as a result of such factors as absenteeism, heavy debt burdens, soil exhaustion, obsolete technical methods, attempts to coerce the labour of freedmen at low wages, and the access of labourers to unoccupied land. However, the latter decades of the century saw improvements as estates came to be owned and directed by London sugar merchants who introduced labour-saving technology and produced centrifugal sugar and high quality rum. As the island's sugar sector declined, the number and importance of the black peasants increased. From the part-time peasants of the decades immediately following slave emancipation, there emerged a new peasantry in the later decades of the century which produced a wide range of articles

of local consumption and export that were valued at more than four times the produce of the sugar estates. The economy of Jamaica thus became more diversified and much better able to meet the decline of the sugar industry than Barbados and the other sugar colonies, with the exception of Grenada. Furthermore, as Richard Lobdell has observed, "in general it is concluded that peasant organized production is more conducive to overall economic development because incomes are distributed in a more egalitarian fashion, because social stratification is less rigid, and because political institutions are more responsive to local needs" (Lobdell 1987: 30).

NOTES

1. I am indebted to Professor Fogel for permission to quote this extract from his forthcoming book.
2. *Journals of the House of Assembly, Jamaica*, Vols. VI-X.
3. *Ibid.*, Vols. VI-X. For a discussion of improvements in sugarmill technology, see Deerr 1949-50: II, 534-95.
4. Dr. John Davy was the brother of Sir Humphrey Davy.
5. *Accounts and Papers (Parliamentary Papers), House of Commons*, "Select Committee on the Condition of Sugar and Coffee Planting in the Colonies, 1847-1848," XXIII, Third Report, 11218, 11264, evidence of Carrington; Deerr 1949-50: II, 552-3; Trollope 1860: 145.
6. Beachey 1957: 81-6, 91; Eisner 1961: 202-3; "Select Committee on Sugar and Coffee Planting," XXIII, Third Report, 28 February 1848, 4536, 4537, evidence of De Walden; Pringle 1869: 29-30; Lobdell 1972: 39-46.
7. *Accounts and Papers (Parliamentary Papers), House of Commons*, "Report of the West India Royal Commission," 1897-98, Vol. L.
8. *Ibid.*, Vol. L, Part II (ii), 257; Part III, Appendix B, 214; Vol. LI, Part XIII, Appendix A, 393, 401.
9. *Ibid.*, Vol. L, Part II (ii), 209, 212; Part III, Appendix B, 214; Barrow 1982: 85, 91-92.
10. *Report of the West India Royal Commission, 1897-98*, Vol. L, Part III, (182), Question 5; *ibid.*, Part III, Appendix A, (109).
11. *Ibid.*, Part II (ii), 217; Part III, (182), Questions 1, 6 and 7; Beachey 1957: 25-26, 33-34, 83.

12. *Report of West India Royal Commission, 1897-98*, Vol. L, Part II (ii), 248; Part III, (182) Question 3.
13. *Ibid.*, Vol. L, Part III, (182), Questions 9 and 11.
14. *Ibid.*, Vol. L, Part III, (226), (237), (242), pp. 602-18. For an account of the poverty of the labouring classes of Barbados at the time of the Confederation Riots of 1876, see Belle 1984: 1-34.
15. *Report of the West India Royal Commission*, Vol. LI, Part XII, (477), (478), (479); Part XIII, Appendix A, (392), (393), (394), (397); Appendix C, (739), (750), (752); Beachey 1957: 123; Eisner 1961: 203.
16. *Report of the West India Royal Commission*, Vol. LI, Part XIII, Appendix A, (394), (397); Beachey 1957: 74-6; Eisner 1961: 298-300.
17. *Report of the West India Royal Commission*, Vol. LI, Part XIII, (319), (320), (321); Vol. LI, Part XIII, appendix C, (754).
18. *Report of the West India Royal Commission*, Vol. LI, Part XIII, Appendix A, (417); Hall 1964: 56-79.
19. *Report of the West India Royal Commission*, Vol. LI, Part XIII, (473), (475); Eisner 1961: 170-1, 205.
20. *Ibid.*, Vol. L, Part III, (186), Vol. LI, Part XIII, (496), (498).

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ALEX VAN STIPRIAAN

THE SURINAME RAT RACE:
LABOUR AND TECHNOLOGY ON SUGAR PLANTATIONS,
1750-1900

In their article in this issue, Boomgaard & Oostindie deal with the question of whether an abundance of cheap slaves was an obstacle to efficiency in sugar production, and whether slavery and advanced sugar technology were incompatible.¹

Addressing these same questions, I shall focus on the history of innovations on Suriname sugar plantations, the development of productivity and profitability, and on the attitudes to innovation among those engaged in Suriname sugar production.

SUGAR AND COFFEE

Although Sugar was King for the better part of the past three centuries in the Caribbean, it is often forgotten that this "sweet monarchy" came under attack many a time and sometimes even suffered a defeat. This was the case for instance in Suriname between 1750 and 1820 (Van Stipriaan 1988: 2). During this period the export value of coffee surpassed that of sugar; between 1760 and 1790 it was even two to four times as high. This temporary predominance of coffee had decisive effects on the development of the sugar sector of the Suriname plantation economy. An analysis of the latter would therefore be incomplete without some preliminary remarks on the coffee sector.

Coffee was introduced to Suriname during the second decade of the eighteenth century. At first mainly a side crop on sugar plantations, it gradually became a plantation sector in its own right. Coffee proved to be so profitable that during the second half of the eighteenth century not one single new sugar plantation was laid out. In the third quarter of that

century, when an abundance of capital in the Netherlands led to large-scale investments in the Suriname plantation economy, almost three quarters of this capital flow was invested in the coffee sector.² Within just a few years at least 150 new coffee plantations were laid out. In the early 1760's the coffee plantations greatly outnumbered the 116 sugar plantations (Pistorius 1763: 26).

Many of these sugar plantations were located in the sandy interior of Suriname. By the time the soils there became exhausted, virtually all the fertile clay lands of the coastal plain had already been occupied by coffee plantations. Lacking alternatives, many sugar plantations had to be abandoned.

The capital flow to the coffee sector also gave this sector an advantageous position on the slave market.

Finally, the abundance of credit facilities, particularly in the coffee sector, resulted in the emergence of a new group of planters. Not hindered by any lack of capital, nor by great experience in planting, they tended towards conspicuous consumption, speculation and sometimes fraud.³ In combination with the soil-exhausting properties of coffee and the fact that mortgage credit was based on the ever increasing appraised value of the plantation instead of the soon decreasing average turnover, this resulted in rocketing debts and an inability to repay their loans in regular installments, or even to pay the interest. As a result, the confidence of Dutch investors was severely damaged, and in the late 1770s credit facilities came abruptly to an end. This was, however, not restricted to the coffee sector, but applied to the Suriname plantation economy as a whole, in spite of the fact that the sugar sector was far less in debt than was the coffee sector.

During the first half of the nineteenth century many coffee plantations were abandoned. This had two important effects on the sugar sector. First, at least 25 of these plantations changed to sugar production. By 1857, well over a quarter of all sugar plantations had formerly produced coffee (Hering 1858: appendix). Due to the long period of exhaustive coffee growing, sugar productivity on these plantations turned out to be far below that of 'authentic' sugar plantations (Van Stipriaan 1988: 5-6). Second, the sugar sector as a whole profited from the abandonment of many coffee plantations by taking over their slave forces. It should be added that this caused a great deal of unrest. Not only did many slaves resist leaving their birthplace, but they often simply refused to work on a sugar plantation, where labour conditions were generally much harsher than those reigning on coffee plantations.

It is clear, then, that an analysis of only one sector of a mixed plantation economy such as the Surinamese would be incomplete: the interaction between the sectors was of great significance. It was no coincidence that sugar production and productivity in Suriname were low when coffee was at its zenith (1770s) and vice versa (1830s).

This interaction also bears on the question of whether abolition of the African slave trade, and eventually slave emancipation, were consequences of declining profits and a quest for free labour. At first sight the data about the deterioration of the once dominant coffee sector and about the enormous indebtedness (also in part of the sugar sector) suggest a confirmation of the decline thesis. Yet when the slave trade was abolished in Suriname (1808), it was precisely at a moment when sugar was recovering, fresh capital (from England) was being pumped into the plantation economy, and a virtually new sector (cotton) was emerging. As a consequence of the Napoleonic wars, Suriname at that time formed part of the British Empire,⁴ and the abolition of the slave trade was simply imposed on the Surinamese planters. After Suriname was again ceded to the Dutch in 1816, it took almost another half a century before slavery itself was abolished. Further on we will discuss whether or not the late date of Emancipation may be seen as proof that slavery constituted no obstacle to technological progress and expansion.

TECHNOLOGY ON SUGAR PLANTATIONS: INFRASTRUCTURE AND THE FACTORY

From North to South, in Suriname, a swampy coastal plain of sea clay with sand ridges, gives way to a sandy savanna belt. This in turn is followed by rocky highlands, which cover the greater part of the country. The first sugar plantations were located along the river banks in the savanna belt and in the intermediate area between it and the low lying coastal plain.

In the beginning of the eighteenth century, new sugar plantations were laid out along the more fertile banks of the Lower Cottica and Suriname rivers. The infrastructural problems posed by these wet, swampy lands demanded new technical solutions, of which the construction of *polders* was the most important. Trenches were dug and dikes erected to drain these lands, and to protect them from floods. Each of these plantations contained two separate water systems: one took in water from the river and acted as a transportation network for flat-bottomed vessels which carried cane from the fields to the factory; the other drained off water from the cultivated fields to the river. Because of the opposite functions

of these two systems, it was crucial that they be in no way connected. Both systems were equipped with costly hydraulic devices, such as sluices, and several types of culverts.

Drainage was further facilitated by planting the cane on plant beds, intersected by small gutters. This lay-out was to become a major obstacle against the use of the plough in Suriname. On the other hand, the water system, in combination with the tides of the rivers in these lowlands, favoured the use of water mills which generated more grinding power than the animal traction mill. Thus the introduction of one innovation (*polders* and water systems), at the same time prevented (ploughs) and promoted (watermills) other innovations.

Initial expenses for the installation of a water mill were much higher than for an animal traction mill. Hence, their introduction took place only gradually during the eighteenth century. Some planters stuck to their animal traction mills well into the nineteenth century either because of the location of their plantation or because of lack of capital, or both. As it turned out in the long run, plantations with water mills stood a much better chance of survival than plantations using animal power.

TABLE 1: TYPE OF SUGAR MILL AND CHANCE OF SURVIVAL

period	source of energy			sugar cultivation abandoned
	animal	water	steam	
1745-1760	34	9	-	-
1775-1780	15	26	-	2
1857	-	11	18	14

Source: Sample of 43 plantations ARA: SONA; Hering 1858: app.

Of the fourteen plantations in this sample which were abandoned by 1857, 12 had been operating an animal traction mill around 1750, and ten of these had used it to the end. Some 80% of the plantations in the sample changed to a more sophisticated type of mill during the years 1745 - 1857; half of these changes occurred during the eighteenth century. Almost one fifth of the plantations concerned changed twice during this period.

More sophisticated mills provided a higher cane crushing and processing capacity. As a consequence, changes also took place in the boiling house.

The growing number of boiling pans shows that an increasing quantity of cane (liquid) could be handled at one time. This was not only due

TABLE 2: NUMBER OF BOILING PANS PER PLANTATION 1740 – 1855

period	average number of pans	standard number with type of mill		
		animal	water	steam
1740-1769	5.3	5	6	–
1780-1809	6.7	5	8	–
1825-1855	7.9	5	8	10

Source: two samples of each 15 eighteenth-century and 13 nineteenth-century plantations. ARA: SONA; plantation records.

to the higher capacity of new types of mills, such as the steam mill introduced around 1815, but also to innovating adaptations in existing mills. For instance, from the end of the eighteenth century cast iron came to replace wood (crushers, waterwheel) and red copper (boiling pans) as the basic material. Also, after about 1820 an increasing number of mills had horizontally-placed cane crushers – which had more power – instead of the traditional vertical ones.

These innovations aimed at increasing cane productivity by raising the extraction rate of juice from cane. After the abolition of the slave trade new labour-saving innovations were added. One example was the introduction of the *doubleuse* or “trash turner” which appeared rather late in Suriname.⁵ This device consisted of a curved shield behind the mill rollers, which turned the crushed cane (“trash”) automatically back for a second crushing. This saved the labour of several slaves who had formerly performed this task by hand.

Another labour-saving innovation was the use of coal instead of wood as fuel for the steam engines. In the 1820s at Meerzorg plantation for example, this costly change was deliberately introduced “to save hands from chopping wood” (Teenstra 1835 I: 223).

In fact, the steam mill itself was a life- and labour-saving device. A steam engine could be put to work at any time. In contrast, a water mill only operated when the tide was high (16 days a month), during which time it was used day and night. Cutting cane during the day did not necessarily excuse a slave from also having to operate the mill at night. Labour shifts lasting more than 24 hours were no exception on these plantations.⁶ This of course had a devastating effect on the slaves’ health. A government enquiry revealed that during the period 1838 – 1842 the excess of deaths over births on nine water mill-equipped plantations was 13.5%, whereas this figure for ten steam-equipped plantations was ‘only’ 6.4%.⁷ Although other variables may also have influenced this difference

in mortality, these figures do seem to indicate that the use of steam power was labour-saving in a very literal sense. Yet, owing to costs, it took some time before steam engines were no longer an exception: in 1833, 28% of the sugar plantations possessed such a device, while in 1862 this had increased to 66%.⁸

Yet, all of these innovations were labour-saving only to a degree. Large scale mechanization only gained momentum around 1850, a date still well before Emancipation (1863). In a few years, 16 out of 86 sugar plantations adopted steam-driven cane and trash carriers, three plantations started to operate a central factory system, two others were equipped with vacuum pans and six began to work with centrifugal devices (Hering 1858: appendix). The latter three innovations both saved labour and increased output. By 1863, a significant part of the sugar sector was thus as highly mechanized as possible.⁹

Technology in the field

The distinction between output-increasing and labour-saving innovations can also be applied to cane field technology. Improvement (or stabilization) of soil fertility by manuring was an example of the first kind. From the end of the seventeenth century it was applied in several parts of the Caribbean (Watts 1987: 399-402). In Suriname the only manuring practices were flooding the fields with river water (and mud) when they had to lie fallow for some years, spreading mud dug up from the trenches of the water systems over the fields, and, during the first part of the growth cycle, leaving the cut cane leaves to rot on the ground. The latter practice however, was usually rendered less effective by burning the fields after the harvest, thereby damaging the top soil. Cow dung or other natural fertilizers were never used in Suriname and it was not until the very end of the nineteenth century that the first reluctant experiments were carried out with artificial fertilizers such as superphosphate and lime.¹⁰

In contrast to their neglect of Caribbean methods of manuring, the Suriname planters were among the first to introduce the most important innovation outside the factory, i.e. new, more productive cane varieties that were to replace the Creole cane. Imported in Suriname in the late 1780s, the Otaheite and Moluccan varieties had come into general use around 1800.¹¹ This resulted in a considerable increase in cane productivity (table 5); at the same time, however, soil resilience decreased severely (Reyne 1922: 23; Watts 1987: 435).

As for labour-saving innovations in the field, no mechanization whatsoever took place in Suriname. In the period under discussion, all over the world

cane cutting was done by hand. Further, as we have seen, the absolute necessity of using plant-beds and drainage trenches in the swampy lands of Suriname prevented the use of the plough.¹² Therefore cane cutting and hoeing in the heavy sea clay remained among the most labour intensive and backbreaking of plantation routines.

In the transportation of the cane to the factory grounds some innovations did occur. On the oldest plantations slaves or oxcarts had done this job. Later, when water systems had come into general use, wooden vessels, punted by slaves, had come to replace them. In the nineteenth century, these again were replaced by iron boats, often pulled by animals. At the end of that century the central factory at the Marienburg plantation, then the most advanced in Suriname, was connected to its five supplying plantations by twelve kilometers of railway tracks (Hoeft 1987: 183).

Ratooning was general practice in Suriname. Compared to some other Caribbean countries, where after every harvest cane had to be replanted, this in itself was a labour saving technique (Watts 1987: 404/405). By further increasing the number of ratoons as happened in Suriname, more labour could be saved (Table 3).

During the eighteenth century production up to and including the fourth ratoon was considered to be optimal. This changed rapidly after the turn of the century. From then on, the same cane stools were used for an increasing number of harvests. Although De Resolutie is the only plantation with post-Emancipation figures, ratooning practices there suggest that this trend continued after 1863. But this change can no longer be considered innovative, for the increase of ratoon age was accompanied by a fall of cane productivity. The fifth ratoon, for example, produced only half as much sugar as the first one.¹³ Instead of being innovative, this policy can only be explained as a consequence of labour scarcity.

Finally, the concentration of labour-intensive activities, such as cutting the cane within a limited period, might have been labour-saving or rather, cost-reducing, particularly during the post-emancipation era. Indentured labour systems however, based on five-year contracts, made this not a viable option. In fact, the opposite happened. In Suriname, owing to the wet seasons, four to five months of the year are less suited to cane cutting, and during the eighteenth century no cane was cut during, on average, 4.3 months a year. During the nineteenth century, before and after Emancipation, this period was reduced to 3.6 months on average.¹⁴ This not only contradicts the theory that during slavery these activities were more spread out over the year to keep the (supposedly abundant) labour

TABLE 3: CANE ACREAGE PER RATOON 1750-1880
(as percentage of total cane acreage)

period	r a t o o n - a g e							(n)
	1	2	3	4	1-4	5	>5	
ca. 1750	24%	22%	18%	17%	81%	10%	9%	29
ca. 1790	27	23	19	15	84	6	10	20
ca. 1825	30	15	15	11	71	15	14	20
ca. 1855	25	22	13	5	65	17	18	9
'De Resolutie'								
1835	16	25	12	7	60	13	27	
1880	17	2	19	10	48	21	31	

Source: Sample ARA: SONA and SNA; plantation archives.

De Resolutie: ARA: SNA, 108 and Rademakers 1985: 99.

force busy, it also suggests that planters were forced to expand cane cutting to less favourable seasons as a consequence of labour scarcity.

PRODUCTIVITY

If slavery had been incompatible with innovation, productivity would have remained at more or less the same level until 1863, to expand only after that date. Yet as we have seen, innovations were introduced long before Emancipation. The question then is: to what extent did these changes influence productivity levels?

TABLE 4: THE AVERAGE PLANTATION 1750-1899.

year	slaves	fieldhands	cane- fields (ha.)	produc- tion (tons)	total number of plantations
ca.1750	113	59 (52%)	52	62.4	135
ca.1790	142	61 (43%)	68	73.8	101
ca.1825	130	62 (48%)	68	120.4	95
1854	208	87 (42%)	87	198.5	86
1862	230	93 (40%)	93	183.7	86
1882	-	190	116	288.1	34
1899	-	710	285	1,366.7	7

Source: see note¹⁵

Between 1750 and 1900 the total number of sugar plantations dwindled from 135 to 7, while during the same period another 50 plantations were established, only to be abandoned again. At the same time the average plantation kept on expanding. Although, for instance, the number of plantations fell between 1750 and 1862 by well over 36%, total cane acreage and total slave population in the sugar sector expanded by 4 and 26% respectively.¹⁶ Changes in the demographic composition of the slave force, it should be noted here, gradually made the total slave population less productive, due to the decrease in, and finally the end of, slave imports (see also table 8).¹⁷ Nevertheless, productivity in general rose spectacularly. Total output of the seven remaining plantations in 1899 still exceeded that of 135 plantations in 1750 by 27%.¹⁸

In order to allow for comparison, I have computed productivity per slave as well as per field hand. Productivity per field hand provides us with the most realistic view, because these labourers took care of most activities in sugar production, and their number relative to the total slave force changed in the course of time. Comparison with the post-emancipation era is also easier this way.

TABLE 5: PRODUCTIVITY OF THE AVERAGE SUGAR PLANTATION 1750-1899

year	production per slave (kg.)	fieldhand (kg.)	ha. cane (kg.)	ha. cane per fieldhand
ca.1750	552	1,058	1,200	0.9
ca.1790	520	1,210	1,085	1.1
ca.1825	926	1,941	1,770	1.2
1854	954	2,281	2,281	1.0
1862	799	1,976	1,976	1.0
1882	-	1,519	2,493	0.6
1899	-	1,924	4,803	0.4

Source: see note 15.

Until shortly before Emancipation productivity per field hand appears to have been constantly on the rise. For a long time this was probably the result of making the slaves work harder, stimulated by the whip, because until the 1820s the number of cane fields per field hand was growing too. The unrivalled growth peak of field hand productivity between 1790 and 1825 (+60%) was, however, also the result of the introduction of more productive cane varieties. The general application of new technology in the sugar factory made productivity grow until well into the 1850s. Growth

of productivity by increasing the workload per slave no longer occurred. This is illustrated by the slight decline in hectares per field hand. More protective labour regulations and a reluctance to work hard(er) when Emancipation seemed imminent, might explain the productivity decline in 1862. However that may be, the productivity level of 1854 was never reached again during the rest of the century. Contract labourers could not be forced to work as hard as slaves had done in former years, and the lack of experience of plantation labour among the growing number of Asian immigrants after 1873 depressed labour productivity even further¹⁹. The rise by 1899 was solely due to innovations in field and factory, illustrated by the further reductions in hectares per fieldhand. In sum, slaves were no obstacle to an increase in labour productivity, and in fact proved to be more productive than (semi-) free labourers.

Cane productivity showed a different development. Due to unfavourable climatological circumstances around 1790, productivity in that year was at an all-time low. With the exception of 1862, cane productivity was always on the rise during the nineteenth century. The 1862 figure was probably influenced by labour tensions and neglect of production in the face of Emancipation, but in general terms the application of new technologies pushed up productivity figures. The most influential of these were the introduction of new cane varieties around 1800, the horizontal, steam powered mill, well before Emancipation, and the general application of the vacuum pan in the 1880s.

These data indicate that the rise in cane productivity was certainly not restricted to the post-Emancipation era. A comparison of the increase between 1790 and 1854 with the rise between 1854 and 1899 shows that both were of the same level, i.e. 110%.

PROFITABILITY

A recurring question in the debate about the abolition of the slave trade and of slavery itself, is whether slave-operated plantations were still profitable on the eve of abolition. Definite answers to this question are more often than not frustrated by the scanty, irregular and chaotic material with which the historian has to deal. Unfortunately, Suriname is no exception. Long series of data are almost non-existent, and the remaining scattered data belong to only a few plantations, which makes the samples rather small. Furthermore, particularly during the 1760s and 1770s when Dutch capital was abundant, one half of the sugar plantations was heavily mortgaged, but when it turned out that these mortgages could never be

redeemed they were, in most cases, simply given up, and the investors received shares in the plantations. This complicates a comparison with those plantations that were never mortgaged. Therefore the figures in Table 6 should be viewed as indicative only.

Profitability is computed here as the quotient of average yearly profits and the average number of slaves on the plantations concerned.²⁰ After all, slaves were a constant at every plantation, they constituted the most precious 'capital goods', and they took care of production.

TABLE 6: PROFITABILITY PER SLAVE ON SUGAR PLANTATIONS
1760 - 1862

period	average profit per slave	(n)	average sugar price (per 100 kg)
1760-1769	Fl. - 9	5	Fl. 33
1770-1779	- 15	6	37
1780-1789	- 38	7	41
1790-1799	23	10	85
1800-1809	8	8	40
1810-1819	21	6	86
1820-1829	60	7	39
1830-1839	8	10	31
1840-1849	12	9	25
1850-1862	17	8	28
1880-1889	25	4	18

Source: plantation archives²¹; prices: Posthumus 1943: 125-128; GAR: Hu., 686.

(All sugar prices are Amsterdam market prices, except 1800-1815 which are London market prices).

Despite rising sugar prices, and owing to the increasing burden of mortgage debts in part of the sugar sector, the sector as a whole worked at a loss at least until the 1790s. By then, however, many debts were considered not collectable and counterproductive, and were written off. At the same time sugar prices skyrocketed as a consequence of the Napoleonic wars and the end of sugar exports from Saint Domingue/Haiti, part of which had previously been sold on the Amsterdam market. Furthermore, the slave population in Suriname had dwindled due to falling imports. Due to all these factors, per capita profits rose considerably.

During the first decade of the nineteenth century profitability declined again due to lower prices at the London market where all Suriname sugar

had to be shipped, and the enormous wartime insurance rates that had to be paid on every shipload.

The end of the war, and high prices and increased cane productivity during the following decade, resulted again in rising profits. These were somewhat reduced, however, by high plantation costs, because during the years of British occupation plantation maintenance had often been neglected. After these recovery costs were dealt with, and thanks to ever growing cane productivity, profitability rose to an all time high during the 1820s, despite the fact that sugar prices declined to a much lower (but more normal) level.

This was immediately followed by a severe drop in profitability during the next decade. This cannot be attributed solely to the fall of sugar prices. Prosperity after the Napoleonic wars had persuaded a number of planters to expand their labour force and/or introduce innovations in their factories. The great expenses involved, had a negative effect on profits.

Although after the 1830s the average price level continued to decline, profitability did not deteriorate any further; it even appeared to increase slightly. This suggests that the great modernization expenses were paying off. The further increase in the figures of the last decade before Emancipation appears to support this assumption, although slightly rising prices may also have contributed to the increase in profitability.

Clearly then, in terms of profitability, 1863 was not the most appropriate moment to abolish slavery. At first sight, the end of the 1830s would have been preferable. But then again, low profit levels during this period were not so much a sign of decline, as a consequence of a process of innovation and expansion, the outcome of which eventually was increased production, compensating for low prices.

This process was continued after Emancipation, albeit at the expense of the majority of sugar plantations, which lost the costly rat race. This however, had been a structural phenomenon since the eighteenth century. The remaining plantations turned out to be quite successful, as illustrated by the 1880s figures.

THE PEOPLE

In many eighteenth- and nineteenth-century agricultural handbooks and descriptions of Suriname society, we are made to believe that planters were arrogant, lazy, and opposed to any change:

"One follows the same old course, because it would be something extraordinary to make more effort than necessary."²²

Yet, it is doubtful if statements such as this may be generally applied to sugar planters; after all, changes did occur.

The same can be said of slaves, who were generally described as lazy, ignorant, and also resistant to change. In twentieth-century literature it is often stated that the presence of such an abundant and cheap labour force was an obstacle to the rationalization of sugar production.

Since the end of the eighteenth century, most sugar plantations were absentee-owned and managed by administrators and directors whose interests did not always coincide with those of the owners. At times such people turned out to be thieves, or alcoholics who caused the ruin of the properties under their care. One should keep in mind, however, that their cases stand out in the plantation archives, whereas the "all is well" remarks do not make a lasting impression.

While in the course of time the majority of plantations had to give up sugar production, innovating plantations stood a far better chance of survival than those traditionally operated (Table 1). It is impossible to determine whether the lack of innovations on the latter plantations was due to conservative stubbornness, or to the inability to attract sufficient investment capital.

Yet, in the sugar sector as a whole, innovations were introduced continuously, and plantation output and productivity rose during the entire nineteenth century. Therefore it seems plausible that a majority of planters, administrators and directors indeed tried to run their operations as smoothly and efficiently as possible. They were striving for the maximization of productivity within the context of their (financial) possibilities.

This can be illustrated by the Vossenburg plantation, where a formerly highly praised director was fired after eleven years because

"from time to time he drinks to excess, which makes [the administrator] fear that this could have the saddest consequences for this property, and particularly a most unfavourable effect on the slave force; to have to report this made him [the administrator] very sad, because Mr. Polichy was known as a bright agriculturist."²³

Despite his unquestioned qualities, Mr. Polichy was fired as his drinking behaviour became a threat to optimal labour conditions.

On this same plantation the installation of a steam engine was discussed several times during the 1830s and 1840s, but every time it was rejected by the owners who thought it too expensive. Yet the management of this plantation could not be termed backward or opposed to change. During the years 1820-1858 at least thirteen improvements were introduced in the sugar factory, including the installation of horizontal rollers.²⁴

A final indication that planters and managers really were interested in modern plantation agriculture can be found in the lists of subscribers to two planters' guides in 1835 and 1858 (Teenstra and Hering). Both books were written to promote a scientific approach to planting, and the second one strongly advocated the application of the latest techniques such as vacuum pans and the central factory system. Almost fifty percent of all sugar plantations were 'covered' by subscribers to the first book (either their owner, administrator or director), while almost forty per cent were covered by subscribers to the much more specialized second one. This does not mean, of course, that all subscribers wholeheartedly supported the views of the authors, but neither can they be accused of remaining indifferent to new developments.

Were slaves opposed to change? Not if it was a change of their own choice, such as running away from the plantation, nor if a change clearly promised to improve their living conditions. Other changes however, often created uncertainty, or worsened conditions and to these they were understandably opposed. Slave resistance to resettlement, when their plantation was abandoned or sold, was common during the nineteenth century. There were also frequent labour strikes against heavy work loads or the cruelty of staff members. Of the Potribo plantation in 1829, the administrator reported with surprise that the director

"had given no other motive for grievances and bad conduct to the slaves, than his continuous insistence on regular and industrious labour."²⁵

Despite his surprise, the administrator, unwillingly, had to give in and replace the director.

There is a correlation between slaves' rebellious behaviour and the turn-over of plantation staff. This is illustrated at the Vossenburg plantation by the average number of severely punished slaves per year and the average number per period of white officials, of which there were never more than two at the same time.²⁶

Were slaves also opposed to technological changes, or incapable of handling more complicated machinery? This is unlikely. No single protest by slaves against technological innovation was registered. When the owners of Vossenburg, for instance, considered the installation of a steam engine, no one mentioned the possibility that slaves would not or could not operate such a device, whereas on other occasions the slaves' possible reactions were always taken into account.²⁸

In virtually every slave list of plantations with a steam engine, one or

more black engineers can be found. No complaint about them was reported. Moreover, when at the Rustenburg plantation in 1858 a group of Chinese indentured labourers worked side by side with slaves, all artisans and engineers were blacks and all Chinese were field workers.²⁹ This again suggests that slaves and advanced technology were not at all incompatible. Certainly, the more complicated the machinery in the sugar factory became, the more planters had to call on specialized technicians to install or repair these devices. But this was no indication that slaves in particular could not do the job; neither could the planters, nor the free local population: the majority of these specialists came from the United Kingdom.

TABLE 7: PUNISHMENTS AND SUCCESSION OF OVERSEERS
VOSSENBURG 1823-1844²⁷

period	average number of punished slaves	average number of white officials
1823-1824	1.0	2.0
1825-1829	4.0	2.8
1830-1834	7.0	3.6
1835-1839	1.6	2.8
1840-1844	0.6	2.2

Source: Sur. Mus.: Coll. Brantsen, Verslagboekjes 1823-1844.

As is well known, the average slave population on a plantation was not a homogeneous mass of field labourers, but a social configuration, differentiated by age, colour (all mulattos were elite slaves and did not perform any fieldwork) and occupation. Especially during the nineteenth century some important changes occurred in this configuration (Table 8).

The number of black overseers grew probably to compensate for a lesser use of the whip, due to more protective slave regulations. The proportion of artisan slaves declined, but their absolute number remained more or less stable, indicating that expanding sugar plantations needed no more than a fixed number of artisans.

The number of domestic slaves showed a relative decline, but their absolute numbers increased as a result of the growing number of white officials who had to be taken care of. All in all, the proportion of elite slaves (A+B+C) declined steadily. This tendency points to a process of 'proletarianization' of the labour force, a not uncommon phenomenon in modernizing enterprises.

This trend seems to contradict the more than proportional decline of the group directly responsible for sugar production, the field labourers.

TABLE 8: OCCUPATIONAL COMPOSITION OF THE SLAVE FORCE
1770 - 1862

period	average popul- ation	black over- seer (A)	artisan (B)	domestic (C)	A+B+C	
1770-1779	147	1.8%	8.4%	5.1%	15.3%	
1820-1835	145	2.0	7.2	5.1	14.3	
1850-1862	205	2.3	5.5	4.4	12.2	
	field work	odd jobs (D)	non- produc- tive (E)	child (F)	D+E+F	(n)
1770-1779	47.2%	4.2%	7.6%	25.5%	37.3%	24
1820-1835	45.4	6.3	8.4	25.0	39.7	20
1850-1862	40.6	6.0	8.9	31.8	46.7	13

Source: plantation records.

In reality however, their average numbers increased after the 1830s, although not as fast as the slave population as a whole (20 and 41% respectively). This unbalanced growth was caused by the rapidly rising numbers of non- or semi-productive slaves during the final decades of slavery (D+E+F). At the end of the 1820s slave imports had virtually come to an end, whereas infant mortality was still high. This resulted in a more than proportional increase in the number of slaves in the non-productive age-brackets. On the other hand, during the final years of slavery the proportion of elderly people remained constant, whereas improved child care resulted in a remarkable growth of the (potentially) productive people of the future. The latter development was partly the result of planters' policies to increase the natural reproduction of labour. This policy was definitely in line with rational labour management.

Nevertheless, the number of 'idle' mouths to be fed had risen to a high level. Substantial growth of productivity, by full-speed mechanization or rationalization of production, might have solved this problem. In reality, the latter process did not proceed fast enough, and productivity even slightly declined (Table 5).

Emancipation, of course, put an end to the planters' legal obligation to take care of the unproductive part of the slave population. The question whether slave labour was more expensive than free labour during the second

half of the nineteenth century still remains to be answered. The scanty profitability figures seem to suggest that it was (Table 6).

Was, finally, a cheap and abundant slave labour force hindering the rationalization of sugar production? It is hard to determine whether slaves were abundant and cheap before the end of the 1770s. Between 1750 and 1780 average yearly imports for Suriname as a whole amounted to almost 4,200 slaves (the plantation population around 1770 was ca. 60,000), and the average purchase price for slaves of all ages was Fl. 255.³⁰ It is difficult to say whether this import was sufficient for the sugar sector. From the end of the 1770s however, slaves were always in short supply and expensive. During the years 1780-1795 average imports amounted to no more than 1,050 slaves per year and their price had more than doubled.³¹ Enormous debts and lack of capital prevented planters from buying new slaves, and this made Suriname unattractive for slavers. Slaves became scarce 'goods' and prices skyrocketed. This was the more serious since at that time the annual natural decrease of the slave population may have averaged 4% (Lamur 1977:163). In the sugar sector the result was a severe decline of the total slave population from almost 17,000 slaves around 1770 to just over 10,000 in 1813.³² Obviously this had negative effects on sugar production. As early as 1786 sugar plantations could be observed

"where one has more cane on the fields, than one can cultivate with the labour force; a shortage of which one can see too many examples over the past few years" (Blom 1786: 55).

In these circumstances the arrival of the higher yielding Otaheite cane variety must have been considered a blessing. Other, more capital intensive innovations to compensate for the labour shortage could only be dreamt of.

After the all-time low population figure of 1813, the sugar sector showed a remarkable recovery. Total slave population in this sector rose from well over 12,000 in 1827 to almost 20,000 in 1862.³³ It is striking that so many slaves were available, because slave imports had completely ended after the 1820s and natural reproduction was still below the death rate, albeit not as seriously as during the eighteenth century. Reconstruction and remittance of old debts, high profits and some fresh credit supplied the necessary capital to make this expansion possible. Also, sugar planters had been buying slave labour from the rapidly deteriorating coffee sector since the turn of the century, and, to a much lesser degree, from the cotton sector after the 1830s.

Again the question arises whether this great influx of slave labour was

an obstacle to innovation. Apparently it was not, because it was precisely during these four decades that the majority of surviving sugar plantations changed from water, or animal, to steam power, all kinds of labour saving devices were introduced, and the first central factory was constructed. This suggests that the existence of a large number of slaves was not incompatible with technological innovation at all; at the same time, it may also imply that there was still a labour shortage.

As for this latter assumption, it turns out that slave labour indeed had not become a cheap commodity.

Again the Vossenburg plantation provides the best example. In the 1760s slaves were bought for this plantation at an average price of Fl. 280 per slave. This rose to Fl. 610 in the 1790s. During the 1820s an average fieldhand cost the owners Fl. 650, the next decade Fl. 1,000 and during the early 1840s even Fl. 1,200 – 1,400.³⁴

To avoid these heavy expenses, the planters might try to hire slaves. This, however, was easier said than done. In the beginning of 1835 it was decided at Vossenburg that a piece of land had to be turned into a polder for new cultivation. It was not until the end of 1838 that 20 slaves could be hired from three coffee plantations to do the job in two months at Fl. 1.25 a day per slave. The same happened in 1852, when the managers had to wait until the end of 1855 to find a labour gang for hire.³⁵

The example of Vossenburg indicates that the release of labour from other plantation sectors was not sufficient to meet demands in the sugar sector. This labour shortage was caused by a chronic, though diminishing, natural decrease of the slave population, by the rapid expansion of some plantations, and by a less oppressive labour regime.

The improvement of labour conditions may have been a deliberate policy in order to lessen the labour shortage. Mechanization was another means to reach this end. Neither of these policies depended on the abolition of slavery. Curiously, at the Meerzorg plantation, the introduction of a steam-driven mill in the late 1820s stimulated demographic growth, whereas Emancipation had a negative influence.

Even if the Meerzorg plantation was not representative of the Suriname sugar sector as a whole, it illustrates at least that Emancipation did not guarantee demographic improvement in the slave population. On the contrary: Emancipation, and the subsequent import of indentured labour from Asia, seem to have given planters the idea that they were now relieved of their human and managerial duty to take care of the labour population. This illustrates that a rational labour policy and free labour were not 'naturally' linked phenomena.

TABLE 9: DEMOGRAPHIC BEHAVIOUR OF THE BLACK POPULATION AT MEERZORG 1818 - 1872

period	natural decrease (yearly average)	natural increase (yearly average)
1818-1827	4.40%	
1838-1842	0.10	
1849-1851		1.94%
1857-1859		0.42
1863-1872	0.37	

Source: ARA: Coll.v.d. Bosch, 141; ARA: MvK, A-792; ARA: OB&W 1828-1876, 3036; SS: slavenregisters; ARA: Coll. Berg, 349.

CONCLUDING REMARKS

Developments in the sugar sector of the Suriname plantation economy can not be analyzed without paying attention to other sectors too, particularly coffee. The boom in coffee production during the third quarter of the eighteenth century attracted the better part of the capital, slaves and fertile lands to this sector, thereby hindering further development in the sugar sector. Moreover, the negative economic performance of the dominant coffee sector gave a bad name to the entire Suriname plantation economy, resulting in a negative Dutch investment climate during the nineteenth century.

Nevertheless, in the sugar sector innovations were always a common phenomenon. In general, plantations innovating more rapidly in the eighteenth century turned out to have a significantly better chance of survival during the next century, than those traditionally operated.

Innovations were partially of an output-increasing, partially of a labour-saving character. The former were part of a process originating long before the nineteenth century, which seems to indicate that there is no clear interdependence between innovation and labour system. Labour saving techniques, on the other hand, were only introduced from the end of the eighteenth century, implying that labour was becoming a scarce commodity. This too undermines the assumption of an incompatibility of technological progress and slave labour.

The extension of the cane cutting period into less favourable seasons and the prolongation of ratoon age during the nineteenth century again point to labour scarcity. This is further confirmed by constantly rising slave prices from the late 1770s, the virtual impossibility of hiring labour gangs in a period when labour supply from other plantation sectors was

very high, and, finally, by the more than proportional growth of the non-productive part of the slave population. Therefore, rationalization of sugar production was not hindered by a supposedly cheap and abundant labour force. Even when during the nineteenth century the influx of labour into the sugar sector was high, so were levels of mechanization.

The assumption that planters or slaves were opposed to innovation may be disregarded as a myth. As long as they could afford it, most planters applied new technology, and slaves were as willing and able as anybody else to work with it.

A result of these innovations was that the productivity of both labour and cane were almost constantly on the rise until shortly before Emancipation. Labour unrest then provoked a slight decline in productivity. Further innovations after Emancipation increased cane productivity again to unprecedented levels. Labour productivity, on the other hand, recovered only belatedly, and during that century never touched pre-Emancipation levels again.

Conclusions about the development of profitability must be drawn with the utmost care, since data are scarce and disjointed. In general, the available data suggest that from the middle of the eighteenth century until the 1790s, the sugar sector produced at a loss, due to heavy debts and relatively low productivity. In a next phase, when most debts were given up as uncollectable and counter-productive (at the cost of the Dutch investors), when prices were relatively high, and when productivity increased considerably (thanks to the introduction of Otaheite cane), the sugar sector began to prosper, reaching an all-time high profitability level during the 1820s. Falling prices and the high cost of slaves and new technology caused a severe drop in profitability during the next two decades. Yet as Emancipation came within sight, the sugar sector seemed to have recovered and, from an economic point of view, to have been prepared for a successful transition to free labour. This appears to be confirmed by the profitability level of the 1880s.

To summarize, in the Suriname sugar sector slave labour and technological progress were by no means incompatible. The introduction of more advanced technology did not have to wait for the abolition of slavery.

ABBREVIATIONS

ARA	Algemeen Rijks Archief, Den Haag
EHB	Economisch Historisch Bibliotheek, Amsterdam
GAA	Gemeente Archief Amsterdam

GAR	Gemeente Archief Rotterdam
Hu.	Collectie Hudig
KIT	Koninklijk Instituut voor de Tropen, Amsterdam
KV	Koloniaal Verslag
OB&W	Onbeheerde Boedels En Wezen, 1828-1876
MvK	Ministerie van Koloniën
PRO	Public Record Office, London
PWIB	Particuliere West Indische Bank
RvP	Raad van Politie
SNA	Suriname na 1828, Notarieel Archief
SONA	Suriname Oud Notarieel Archief
SS	Staats Archief Suriname, Paramaribo
Sur. Alm.	Surinaamsche Almanak
Sur. Mus.	Surinaams Museum, Paramaribo

NOTES

1. See the Introduction of Boomgaard & Oostindie in this volume. I should like to express my gratitude to both Peter Boomgaard and Gert Oostindie for their constructive criticism, and their moral support.
2. Sample of 313 mortgaged plantations in GAA: NA, 9003-10365.
3. Van Stipriaan 1987:16-7.
4. During the years 1799-1802 Suriname was a protectorate of Great Britain, and from 1804-1816 it was a British colony. In 1807/1808 the African slave trade was abolished in all British colonies.
5. According to Watts (1987: 420) this invention was introduced around 1755, while in Suriname it was not found before the early nineteenth century (Teenstra 1835 I: 220).
6. ARA: Van den Bosch, 142.
7. ARA: M.v.K., A792. At Meerzorg plantation the difference was even more astonishing. Total death surplus of the years 1818-1827 was 39.5%. In 1828 a steam mill was installed. In the years 1838-1842 the percentage of deaths over birth dwindled to a mere 0.3%. (ARA: Van den Bosch, 141; ARA: M.v.K., A792). Note that these figures concern slaves of all ages.
8. Teenstra 1835 I: 82; KV 1862.
9. An example of this mechanization is provided by the government-owned plantation Catharina Sophia. In the early 1860s this plantation had three steam engines, which operated a traditional boiler and pump, a multi-tubular boiler, four clarifiers, two cane carriers, two trash carriers and a trash elevator, while transportation over the factory grounds was provided by well over half a kilometer of railways. (ARA: PWIB, 146)

10. This started in 1874 at plantation De Resolutie, where it was literally stated that "up till now, manuring has not been applied in this colony". (Cited in Reyne 1922: 23). In the 1830s a few planters seem to have experimented with cow dung, but according to a planters guide, this was soon given up as worms entered the cane stool and its roots (Teenstra 1835: I: 202).

11. Reyne 1922: 22 and inventories of plantations Groot Chatillon, Perou, Libanon, Hooyland, Soribo and Roosenburg. (ARA: SONA, 292 and 295; GAR: Hu, 229).

12. In some plantation inventories ploughs were mentioned, but these were probably only used when old sugar fields were prepared for fallowing.

13. Production figures of a sample of 11 plantations revealed that, compared to the first ratoon, the second produced 92%, the third 70%, the fourth 66% and the fifth 56% of its sugar quantity. (Plantation archives 1820-1860.)

14. Samples of 20 plantations producing during 1750-1799 and 15 plantations during 1820-1860 (ARA: SONA and SNA; and plantaton archives) and Hoeft 1987: 241.

15. Table 10: Suriname sugar sector 1750-1900.

year	slaves	fieldhands	cane area (ha.)	production (kg.)
ca.1750	15,315	7,924	7,021	8,423,663
ca.1790	14,292	8,575	6,875	7,452,266
ca.1825	12,352	5,925	6,459	9,621,333
1854	17,884	7,442	7,442	17,068,533
1862	19,789	7,977	7,977	15,800,256
1882	-	6,448	3,929	9,794,133
1899	-	4,972	1,992	9,566,752

Source: 1750-1825 are extrapolations based on samples of ARA (SONA and SNA), and plantation archives, in which $n = 44$ (1745-'55), 28 (1783-'95), 18 (1820-'29). The number of plantations is based on ARA: RvP, 607 (1750); Surinaamsche Staatkundige Almanach 1796 (1790); ARA: Van den Bosch, 161 (1825). All data 1854-1899: KV of relevant years. All production figures are 3-year averages based on Nassy 1791: appendix; GAR: Hu., 164; Van der Voort 1973:237 and 260; Sur. Alm. 1824-1826; KV of relevant years. For the years 1882 and 1899 all indentured labourers are considered field hands.

16. Ibidem.

17. The increased percentage of field hands in 1825 was a result of the paradoxical situation that after the abolition of the slave trade with Africa, illegal imports and imports from the French and Danish islands, which were not forbidden, rose to a level unknown since the 1770s. In 1828 this trade came to a virtual stop as a result of the introduction of compulsory slave registration.

18. See note 24.

19. After Emancipation a 10-year apprenticeship system was introduced. After 1873, the large majority of ex-slaves left the plantations and were replaced by indentured labourers from British India and, later, from Java.
20. Profits are calculated as total income minus all costs. This includes all plantation costs, transportation costs, market costs, mortgage costs and interests.
21. Data from plantations: Aurora, Bleyendaal, Catharina Sophia, Crawassibo, Groot Marseille, Kroonenburg, Libanon, Lunenburg, Meerzorg, Perou, Potribo, Rustenburg, Sinabo, La Singularité, Siparipabo, Vossenburg, Vreedenburg, Waterwijk, Wayampibo, Wolffs Capoeira, Zoelen, Zorg en Hoop.
22. KIT: Coll. Van Breugel.
23. Sur. Mus.: Coll. Brantsen, Verslagboekje 1835.
24. Ibidem, 1820-1857.
25. GAA: PA-600, 544.
26. In the plantation hierarchy white officials held a rank below that of plantation director.
27. These punishments concern only the most severe crimes, such as running away or violent behaviour.
28. Sur. Mus.: Coll. Brantsen, Verslagboekjes 1834 and 1848.
29. ARA: PWI-Bank, 179.
30. Goslinga 1985: 615-619; Postma 1975: 237-242; plantation records.
31. Ibidem.
32. 1770: extrapolation based on a sample of 41 sugar plantations; 1813: PRO: T-75, 14 and PRO: Co-278, 15.
33. 1827: ARA: Coll. Van den Bosch, 161; KV 1862.
34. EHB: KA-87, 17; Sur. Mus.: Coll. Brantsen, Verantw. Rek.
35. Sur. Mus.: Coll. Brantsen, Verslagboekjes for relevant years.

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SUGAR TECHNOLOGY AND SLAVE LABOR IN MARTINIQUE,
1830-1848¹

The sugar plantation or *habitation sucrière* as it was called in Martinique, integrated within a single productive unit both the agricultural and manufacturing operations necessary to produce sugar. The interdependence of the various sectors of the production process developed the industrial character of sugar production while constraining it within technically determined limits. The plantation formed an integrated mechanism. Each phase of the sequential process of production depended upon the preceding ones. The distribution of labor and resources within each sector had to be coordinated with the other sectors. The organization of the production process as a whole impelled the maximization of output in each individual sector and of the speed and continuity between sectors. At the same time, this tendency was counterbalanced by the need to maintain the technically determined equilibrium among the various sectors of the process. While the ideal limit of production remained the complete extraction and conversion of all the sucrose contained in the cane plant, a wide variety of techniques, all with a significant effect on the quantity and quality of the product, was practiced in every phase of the process; and the selection of particular techniques depended upon an enormous variety of political, economic, social, and technical conditions that differed from estate to estate. The transformation of the world and national sugar markets during the first part of the nineteenth century created conditions for improvements in productive technique that developed this integration of agricultural and manufacturing processes to its fullest extent while exposing the self-contained plantation as the limit to technological improvement in the colonial sugar industry.

By the 1830s, the need to reform the organization of sugar production

pressed upon the plantation system in Martinique. Competition from metropolitan beet sugar and foreign cane sugar constantly threatened the market position of the colonial product. Further, with the rapid expansion of the previous decades, the effective physical limits of cultivation on the island had been reached, while the abolition of the slave trade prevented the planters from increasing their labor force. Finally, the rapid technological progress of the beet sugar industry made the reappraisal of colonial production in the light of scientific principles a necessity. From the end of the eighteenth century onwards, there were a series of advances in every aspect of sugar manufacture. The appearance of new techniques including steam-power, the all-metal horizontal grinding mill, the clarifier, carbon filters, the swing boiler, steam heat for evaporating and boiling, and most importantly, the vacuum pan revolutionized sugar production. For the most part, these advances originated in the French beet sugar industry which was compelled to seek every possible means to off-set the natural disadvantages of the sugar beet. The European beet sugar industry quickly became what Eric Williams (1970:380) has aptly described as "the great school of scientific agriculture." In France, scientific understanding of the process of refining sugar was raised to a new level, and manufacturing techniques were developed that were proven by practical experience. These innovations were directly applicable to the colonial sugar industry; however, the problem of their assimilation into the technical, economic, and social organization of the West Indian plantation remained to be resolved.

There was a wide variety of individual responses to these new conditions by the West Indian planters. The majority of planters lacked the means and often the inclination to apply scientific principles to colonial production and to adopt the methods developed in the beet sugar industry. Traditional routines remained the norm, and the pace of change was slow. But not all of the planters submitted to their fate passively. Sainte Croix, among others, argued that the advances of beet sugar production should be adapted to colonial sugar manufacture.

The successes of beet sugar manufacture in Europe show how science combined with experience can lead to rapid progress.... Let us profit from the efforts of our rivals and use their means in the hope that, in treating a richer and less complex material than theirs, we will arrive at more advantageous results. (Sainte Croix 1843: 3-5.)

Some colonial planters hoped that by ameliorating their wasteful manufacturing methods, the natural superiority of cane over sugar beet would enable them to overcome the challenge of their metropolitan rivals and restore colonial prosperity. In the words of one such planter: "There is,

thus, enormous wealth which perishes each year in the colonies. It is an imposing reserve which cannot but be developed a few years from now and which will change completely the face of the debate." (Gueroult 1842: 64-67) The processes and techniques of colonial sugar production underwent systematic scrutiny by agronomists, engineers, political economists, and by the planters themselves, and an unprecedented number of technical treatises were published. There were a growing number of attempts to experiment with the new technology, and in 1839, in the face of hostility of many of their compatriots, a group of leading planters founded the *Société d'agriculture et d'économie rurale* to study and promote the scientific improvement of agriculture in the colonies. (Martinique, 9 [99]; Lavollée 1841:83; Derosne and Cail 1844: 6; Moreno Friginals 1976: 111; Schnakenbourg 1980: 175-178)

The debate among the planters was not whether to accept or reject technological innovation, but under what conditions it could be successfully implemented in the colonies. As a result of long and successful experience, progressive planters like Guignod, Sainte Croix, and Jabrun were cautious in their approach to reform. Their empirical approach to plantership made them suspicious of abstract formulas and general panaceas and heightened their sensitivity to local variations. They rejected risking wholesale renovation of production techniques, the outcome of which was, in their minds, uncertain. Instead, they choose to emphasize the gradual perfection of the existing organization of production through partial reforms and attempted to adapt each individual plantation to its particular local conditions. Changes were adapted to and elaborated within the prevailing division of labor. During these years, the *habitation sucrière* attained its most complete development and exhausted its technical possibilities. While the processes of sugar production underwent gradual modification, the basic structure of the self-contained plantation remained intact on the scale on which it had been established in the seventeenth century and suppressed alternative paths of development (Généralités, 52 [449]; Sainte Croix 1843; Généralités, 56 [543]).

Given the social and technical conditions of sugar production in Martinique, this course of action was not illogical. The problem with such a solution, however, was that the planters were guaranteeing their own obsolescence. The changes they introduced were not always insignificant, but their consequences were limited by the effects of the integration and interdependence of the organization of the plantations as a whole. By themselves, they were neither sufficient nor widespread enough to rejuvenate the colonial sugar industry. Furthermore, the planters' vision, never realized if not unrealizable, of a perfect balance of the elements of production

where men, implements, land, and animals were combined in complete harmony and with maximum efficiency, led them to reject the steam engine and the vacuum pan, the two most revolutionary technical advances in sugar manufacture during the nineteenth century, as being incompatible with the organization of the plantation. Martinique thus continued to lag behind both the French beet sugar industry and other tropical cane sugar producers. In the face of an expanding market, dynamic competitors, and the constant transformation of production processes, the pressure against them could only continue to mount and create the need for more radical solutions.

The new techniques of sugar manufacture were adopted either individually or in various combinations by a number of planters in the French West Indies. However, their utilization was confined to a minority of large, well-off estates whose owners were in a position to experiment with them, and they failed to resolve the malaise of the colonial sugar industry. The most immediate obstacle to the adoption of the new technology was the lack of money and credit in the colonies. Three-quarters of the planters in the French West Indies were indebted for sums equivalent to half, and sometimes the entirety, of the value of their real and moveable property, and uncertainty over the resolution of the colonial question had sharply restricted commercial credit. (Derosne and Cail 1844: 16-18; Généralités, 56 [543]). In Daubrée's view, some of the richest planters, who operated on a large scale, were in a position to successfully renovate their entire production facility, but for the great majority, who produced on a more modest scale and only made enough to maintain their operation, this was out of the question. Without even considering the vacuum pan, he estimated that there were not 10 out of 100 who were able to bear the expense of a steam engine or a horizontal grinding mill and not 5 out of 100 who could afford to renew their entire milling and refining system. (Daubrée 1841: 28-31)

Yet the shortage of capital, important as it was, was not at the root of the problem. Rather, the self-contained plantation and the organization of labor as slave labor as they had been historically constituted in Martinique had become the chief obstacles to the transformation of the production process. The closely integrated technical organization of sugar production and the need to maintain the balance between its various elements, including labor, gave internal solidity to the sugar plantation and made it resistant to change. The relation between the agricultural and manufacturing operations on the *habitation sucrière* in Martinique was established within definite proportions by the physical requirements of sugar production. At the same time, the appropriation of workers as slaves fixed labor in

relation to this technical division of labor. A determinate number of workers were adapted to the preestablished organization of the labor process. Once production was established on a given scale, it could be expanded only if all the sectors were increased proportionally and labor was appropriately redistributed. Within limits determined by the quantitative relation between sectors, small economies or inefficiencies in a particular sector would only have a limited impact on overall productivity. But any significant attempt to increase the capacity of one sector without corresponding changes in the other sectors would simply create a disequilibrium and waste the intended economy. The changes either became superfluous or increased the burden on the other elements of the process requiring longer and harder use of slaves, land, animals, or equipment. For example, the adoption of the plow might allow more land to be cultivated and increase the size of the harvest. But such an innovation might upset the balance between arable land and pasture. Valuable pasturage could be reduced just when more animals were needed to draw the plow; or, conversely, the potential advantages of the plow could be offset by maintaining or increasing pastureland at the expense of land for sugar. Beyond this problem, increasing the amount of land cultivated and the size of the harvest, even if it were possible, could intensify the pressure on the slaves, the transport system, the fuel supply, the mill, and the refinery, yet have only a limited effect on final production unless the capacity of each of these sectors was increased accordingly. Finally, the capital investment entailed in restructuring the labor process might become prohibitive if, for example, in addition to buying new implements, more slaves had to be purchased. (Tomich 1990; Ministère du Commerce et des Manufactures 1829:53; Moreno Fraginals 1976: 26; Green 1973: 448-463.)

The importance of this technical limitation of slave sugar production becomes more evident in an old plantation colony like Martinique. By 1714, its primary sugar lands had been occupied, and the majority of the estates in existence during the July Monarchy – including all the principal ones – had already been established. The scale and level of productivity of these plantations had been determined by the relation between agricultural and manufacturing operations during that epoch. The capacity of the mill and the need for the cane to be planted near it, especially given the bad state of transportation, had determined the extent of land that could be profitably cultivated and the size of the labor force. Once most agricultural land on the island had been occupied through the multiplication of these productive units, the relation between agriculture, manufacturing, and labor was stabilized. An equilibrium was formed around the amount of land that could be cultivated on a given estate.

The pressure from either sector, field or mill, to increase the efficiency of the other was reduced. (Tomich 1990)

Under these circumstances, the technological transformation of the labor process was restricted by the structure of the plantation as a whole rather than the particular conditions in any individual sector. Thus, for example, steam power did not revolutionize sugar manufacture in Martinique, but rather was adapted to the existing organization of production. The potential improvement in production represented by the steam engine was inhibited by the technical limits of the mill. Up until 1840, sugar mills were designed to be used with any source of power; none were manufactured especially for steam. Instead, steam engines were substituted for other sources of power and adapted to existing mills. The most successful adaptation appears to have been to the new all-metal horizontal mills of the type introduced by Fawcett, Preston, and Company. However, while this combination allowed a greater mass of cane to be ground, it resulted in no improvement in the rate of sugar yielded from a given quantity of cane. In Martinique, the steam engine was frequently used in conjunction with the old vertical mill which, as Sainte Croix emphasized, had a capacity of 600 litres of cane juice per hour no matter what source of motive power was used. (Moreno Fragnals 1976: 102-103, 106; Sainte Croix, 1843: 28)

The great advantage of the steam mill in the eyes of the planters of Martinique was not that it produced more sugar than mills powered by other sources of energy, but that it provided a more reliable and regular source of motive power, and spared the enormous expense of mules and oxen. W. Macomb, an engineer who, with the backing of one of the Perrier brothers, proposed to convert the sugarmills of Martinique to steam power, wrote to Governor Donzelot in 1820:

The great interest of the colonists is to adapt the steam engine to the presently existing mills and by that means to replace the incomplete force of water for those who lack it and the costly use of mules whose labor, as I have said, is subject to a number of disadvantages and which is of no use when they are unfit for service.

The steam engine, he continued, could replace the second-rate and bad mills which had a number of disadvantages, by a solid, dependable machine which always generated sufficient power and could be easily and cheaply maintained. Not only would the power necessary for grinding be more reliable, but the continual cost of mules, and slaves to work and care for them, could be saved and the loss of foreign exchange to Latin America for their purchase avoided (Martinique, 20[169]).

The great obstacle to replacing mules and other inadequate sources of

power with steam was the expense involved. Planters were reluctant to purchase steam engines not only because of the cost of new machinery, but also because the considerable amount of capital already invested in existing mills would be lost if these facilities were abandoned in favor of the steam mill. For this reason, Macomb proposed adapting steam power to the existing apparatus of the sugar mill rather than replacing this with new equipment and buildings. He argued that the best solution to the problems of the sugar industry in Martinique was to fit the steam engine to the already existing mule-driven mills. A four horsepower steam engine, he maintained, was most appropriate to this task (Martinique, 20[169]). Thus, the application of steam power was initially conceived within the framework of the already existing structure of the sugar plantation. Not only was the potential of steam to transform the production process suppressed by subordinating it to this technical and social organization, but the mill remained underpowered. According to Daubrée, the force necessary to grind sugar cane was commonly underestimated. The new steam mills installed in the colonies did not have more than six or seven horsepower and generated insufficient power. Ten to twelve horsepower was the minimum necessary, and in New Orleans, where admittedly the mills were larger than in the French colonies, the smallest steam engine in use had twenty horsepower. (Daubrée 1841: 25-26) Thus the adoption of steam power in Martinique reinforced a form of plantation organization that was becoming increasingly outmoded under the changing conditions of the nineteenth century world economy.

Within the framework of the *habitation sucrière*, the technical division of labor (the division of tasks) and the social division of labor (the division of laborers) reciprocally develop and constrain one another. The interdependence of agricultural and manufacturing operations leads to the elaboration of specialized tasks performed by different workers or groups of workers, and their integration within a unified and continuous process. Thus, it develops the cooperative character of labor as a collective force, but only within technically determined qualitative and quantitative limits, beyond which the socialization of labor is blocked. Conversely, within these technical limits, the social relations of slavery allowed the development of the social character of labor, the increase in the scale of production, and the expansion of the division of labor. But, as Weber and Hall among others have pointed out, the physical appropriation of the *person* of the laborer as the property of the slave owner and the assimilation of the labor force into the constant capital of the estate impeded the adoption of new technologies, the development of the division of labor, and the

transformation of the labor process. (Hall 1961: 348-349; Weber, 1978 I: 162-163) Within the slave form, labor could be adapted to a given technical organization of production. But once the scale and the degree of complexity of production are established, innovation does not save labor or increase the rate of surplus production. Even though the total product may be increased and the labor component of each individual product diminished, the cost of labor, i.e. the cost of slave maintenance, remains independent of the amount of sugar produced. If technological innovation replaces labor in the production process, the slave laborers remain the property of the slaveowner. They can neither be dismissed nor easily adapted to the new technical division of labor in the required proportions, and, whether they work or not, they must be maintained in order to preserve the value of their person. Thus, the specific form of production relations itself restricts technological innovation and the development of the cooperative force of collective labor. Rather than the rationalization of the labor process, the result of such efforts is the intensification of the activity of labor and the rigidification of technical and social conditions of production (Tomich 1990: chapter four).

The relation of slave labor to technological change has been the subject of historical controversy and requires further discussion. The limited impact of the new technology on West Indian sugar manufacture has frequently been attributed to the unsuitability of slaves for any but the simplest routine tasks. Indeed, the incompatibility of slave labor with mechanized production processes has virtually become a commonplace in much historical writing. However, to interpret the failure of these new technological advances to rejuvenate colonial production as due to inability of slaves to perform specific concrete tasks is a one-sided view that risks misperceiving the relation of slavery and technological change. Among the evidence, the observations of Victor Schoelcher cast doubt on the accuracy of such a formulation of the problem. In the face of claims by some planters such as Sainte Croix that slaves were incapable of operating steam engines, Schoelcher noted: "There are some steam engines in the French colonies. There are many of them in the English colonies. Everywhere it is the blacks who run them." (Schoelcher 1842: 158) The antagonism between slavery and the technological transformation of the labor process is not reducible to the incapacity of individual laborers, whether attributed to their biological or their social characteristics, but derives from the social form of the organization of labor itself.²

In opposing the prejudices of colonial planters against innovation and against the capability of slave labor to utilize it, the proponents of the new technology emphasized its simplicity and its role in imposing a new

discipline on the activities of the laborer. The purpose of the new machinery was to do away with the complicated manual labor entailed in sugar manufacture and simplify the activities of the worker (Daubrée 1841: 27; Derosne and Cail 1844: 15-16; 23-24). The new devices required no specialized knowledge or skill. Derosne, describing an early version of his refining system that combined clarifiers, carbon filters, and flat-bottomed copper swing kettles, contended that "Any Negro boiler, in one operation, may be taught to use it, without fear or possibility of anything going wrong." (Derosne 1833:12). Similarly, the routine operation and maintenance of the steam boiling pan was so simple that, according to Jabrun, there was not a worker in the colony who was incapable of learning to run it in a day (Généralités, 56[543]).

The relationship between technological innovation and slave labor was posed most sharply by the vacuum pan. With each historical development of the instruments of production, the manufacturing process appeared less and less as simply the combination of the subjective activity of various specialized workers, but rather progressively assumed an objective organization which confronted the workers as an external, pre-existing material condition of production toward which their activity must be oriented. The vacuum pan carried this process to its extreme consequence. It substituted mechanical power and the conscious and systematic application of scientific principles for the skill, dexterity, and strength of the worker. It was the most complex and sophisticated apparatus introduced into the colonies and the one most responsible for revolutionizing the methods of sugar manufacture. An examination of its impact on the labor process can thus illuminate the general process, common to one degree or another, to the adoption of all the other technological advances.

Describing their system of vacuum pan evaporation, Derosne and Cail wrote:

Combining the machines with care, the operations have been facilitated and made independent of the workers' lack of attention in such a way that today the worker is subject to the machine itself and is unable to incur the faults that bore witness to his incapacity in the old system. And for the very reason that with the new processes the worker is relieved of every laborious operation, more sustained attention can be demanded of him (Derosne and Cail 1844: 15-22).

This system may have been more complex than the implements previously used in its place, but the work performed by the individual slaves became simpler. The purpose of this new machine was the suppression of manual

labor in terms of the difficulty and complexity of the tasks and of the number of workers required to perform them. As manual labor was reduced or eliminated, the craft, skills and subjective judgement of the workers were appropriated as the property of the machine. As particular workers lost their skills and control over their working activity, the vacuum pan reintegrated work as a collective social process through the extension and deepening of the division of labor and the reconstruction of the relation between skilled and unskilled labor. While the skilled workers stepped back from the immediate labor process and became the superintendents of the machine, the unskilled workers were more directly and thoroughly subordinated to its rhythms. The instrument of labor, freed from control by the worker and transformed into a self-activating mechanism, represented the integration of the workers' activity on the one hand and the domination of the planter over them on the other. The regulation of material production by the machine was at the same time the imposition of labor discipline. The vacuum pan fused the technical supervision of the process of material production and social control over the activity of the workers whose previous separation had been expressed in the coexistence of the black sugar master and the white sugar master. Management was simplified and aspects of it put in the hands of technicians while the workers' activity was subjected to a new sphere of control.

In the colonies as in France, the complexity of the vacuum pan required a small group of specialized workers for its operation. These generally included an engineer and one or two mechanics or boilermakers. The selection of these workers had less to do with their civil status than with their technical competence. Persons with the necessary qualifications were generally not to be found among the colonial population, slave or free, but rather had to be brought from the metropolis. To focus on the failure of slaves to occupy these positions misses the larger point of the transformation of the labor process and the shifting locus of control over it. Beyond the technical staff, "the main part of the manufacture is only composed of very ordinary labor, as much within the scope of the Negroes as the present manufacture". Far from exerting pressure to transform the social relations of production throughout the other sectors of the labor process, this isolated nucleus of free workers was dependent upon slave labor and constrained by its presence. The slaves adapted themselves to this new work regime so successfully that the extent to which the technical staff entered into its routine operation beyond the most general supervision may also be questioned. On the plantation of A. Vincent of Bourbon, where pioneering efforts were made with the vacuum pan beginning in 1838, "All the workers... are Negroes, and, nevertheless, they have not

had the least difficulty in habituating themselves to the management of the machines." On the estate of Vila-Urrutia in Cuba, where Derosne's vacuum pas was producing 12,000 kilograms of crystalized sugar a day in 1843: "The factory had no other white worker than the sugar master. All the rest of the personnel was composed of Negroes, who have mastered their work very quickly" (Daubrée 1841: pp. 34, 51-52; 76, Derosne and Cail 1844: 8, 15-16, 21-24; Moreno Fragnals 1976: 111-112).

For the critics of colonial agriculture, it was not the ability or inability of slave laborers to operate the new equipment that was the impediment to reform, but the lack of qualified mechanics who could make essential repairs on it (Derosne and Cail 1844: 15-16). The vulnerability of fragile and sophisticated equipment without the development of a technological infrastructure to support it is illustrated by an incident recorded by Governor Mathieu in 1847. While he was visiting the *usine centrale* of the Sinson brothers in François, the iron grinding mill broke down. There was no way to make or replace the broken parts, and the Sinson brothers had no auxiliary mill. The neighboring plantations either had their own sugar to refine or were dependent on the *usine centrale* themselves and could not offer any assistance. The Sinson brothers were faced with the failure of their harvest, the loss of their credit, and ultimately their own ruin and the ruin of the properties dependent upon them. However, Mathieu, believing in the importance of their project as an example for the entire colony, acted promptly. He offered the services of a naval engineer and two blacksmiths from a naval vessel. The principal parts, which would have required four or five months to obtain from France, were replaced with hardwood. A new drive shaft was fashioned in the arsenal and various other broken parts repaired. The mill was back in operation in a month. A foundry had been established in Trinité by M. Gastel in order to serve the needs of the modernized plantations but had been unable to supply the necessary parts either in this case or in a similar breakdown on a nearby plantation four months previously (Martinique, 7[83], 20[170]). Lavollée reported that there was only one qualified mechanic in Sainte Pierre, and his services were very expensive. To resolve such difficulties, Derosne offered to send and subsidize a selected group of experienced machinists to each colony that purchased his equipment in order to install, maintain, and propagate his system (Lavollée 1841: 75-76).

Thus, the contradiction between slave labor and technological innovation does not reside in the capacity or incapacity of the individual worker to perform specific concrete tasks; rather, the specific character of slavery as a social relation determined the conditions under which such changes

could be implemented, and their consequences for social and economic development. In the slave relation, the instruments of labor did not function as capital. The reorganization of production did not save labor, i.e., did not diminish the number of workers at the disposition of the slave owner or reduce the cost of their maintenance either relatively or absolutely. De Lavigne, for example, testified before the commission on the sugar industry that he had used a plow on his plantation for ten or twelve years. Before its adoption, he had 200 slaves and cultivated 50 carrés of sugar. Afterward, he cultivated 100 carrés of which 75 were harvested in an average year, but he still had the same number of slaves. Thus, technological innovation increased the amount of sugar produced but did not reduce the number of slaves. The cost of slave maintenance remained unchanged, and their labor was distributed over a larger product. Significantly, De Lavigne attributes the adoption of the plow in Martinique to the shortage of labor caused by the abolition of the slave trade, an event outside of the rationalization of the labor process. (Ministère du Commerce et des Manufactures, 1829: 73-74; Lavollée 1841: 5-13; Reed 1866: 75-78; Hall 1959: 65-66).

Such reorganization of the labor process simultaneously intensified labor and created redundant laborers. The expanded production demanded greater effort of the slaves and shortened their working lives. At the same time, the greater output per slave created a superfluity of laborers whose presence not only drained the slaveholder's resources, but could smother the changes made in the labor process, as the experience of a planter in the British Caribbean suggests:

The plough is certainly coming into more general use than formerly.... I was, in fact, compelled to adopt this system, by the small number of slaves which I possessed in proportion to the quantity of cultivable land; and I ... only discontinued it in consequence of having purchased about fifty additional negroes, whose labour, although of the greatest importance at certain periods of the year, could not have been fully available but by this filling up the intervals of diminished exertion.

The transformation of the labor process was blocked. Either machines or men were underutilized. Since labor remained at the disposal of the slaveowner and had to be maintained whether there was work or not, the slaveowner's concern was that it be usefully employed. On the other side, the intensification of work called forth slave resistance. Even if, for example, the use of the plow reduced the back-breaking toil of planting with a hoe, for the slave the larger crop simply meant more work during the harvest without any positive effect on his consumption. Thus, slave

labor could be adopted to a given division of labor, but technological innovation and the alteration of the labor process did not reduce either the number of laborers or the costs of maintaining the slave labor force. Rather, the immobility of the division of labor was reinforced. The rigidity of the organization of production and its resistance to structural transformation were strengthened. The result was that labor was more intensively exploited within fixed technical conditions, and the contradictory character of the slave form was heightened (Sainte Croix, II, 1822: 105; Hall 1959: 49, 60).

The resistance of the *habitation sucrière* to change was the chief obstacle to the technological transformation of the colonial sugar industry in Martinique. The rigid structure of the self-contained sugar plantation worked by slave labor restricted technical innovation. To the extent that the adoption of new refining techniques simply extracted more and better sugar from the same amount of juice, it did not upset the internal equilibrium among the various sectors of the production process. But such reforms integrated the division of labor on each individual plantation ever more tightly. The reorganization of production processes within the established form of organization became increasingly elaborate. The changes in production technique resulted in smaller and smaller marginal increases in output, while the internal structure of the plantation as a whole became ever more solidly congealed. Moreover, as Daubrée argued, even presuming that the planters had sufficient finances and were able to adapt simple reforms such as steam-powered horizontal grinding mills, clarifiers, and copper swing boilers to their manufacturing operation, the increased yield would be insufficient to off-set the rapidly advancing beet sugar industry. Despite the gains in colonial production, its position relative to beet sugar in the French market would continue to decline (Daubrée 1841: 29-30).

Daubrée maintained that only the total reorganization of colonial sugar manufacturing would enable the planters to resolve in their favor the competition with the metropolitan beet sugar industry. In his view, if the methods of sugar refining used in France, including steam boilers and vacuum pans, were adopted in their entirety in the colonies, production would double, and the richer sugar content of the cane plant would secure the advantage for the colonial planters. The more the perfection of these techniques permitted the extraction of all the sugar contained in the cane plant, the more the balance would swing in their favor. However, as Daubrée demonstrated, even if the average planter in the French Antilles doubled his individual output, he would still operate at a loss because of the enormous investment required by the new machinery. The plantation units in Martinique had become too small to be productive. To make effective

use of the new refining technology, Daubrée estimated that a plantation had to produce at least 400,000-500,000 kilograms of sugar annually. This went far beyond the scope of even the largest plantation in Martinique which, at most, produced no more than half that quantity of sugar each year. Furthermore, the immense amount of raw material necessary to attain such a result required that the area under cultivation be drastically expanded. Unlike some of the British Caribbean colonies, Louisiana, or parts of Cuba, this alternative was no longer possible for individual plantations in Martinique. Instead, the necessary relationship between the various sectors of the production process prevailing on each plantation unit formed the historical limit to technological innovation.

The alternatives before the planters were clear: either reject the radical implications of the new technology and attempt to amend the existing structure of production through partial reforms, or radically recast the division of labor and integrate the new methods of production into a new form of plantation organization. However, under the conditions prevailing in Martinique this latter course required the transformation of labor and property relations to be effective. Thus, while the *usine centrale* which completely separated refining operations from agriculture first appeared in Martinique between 1830 and 1848, its development was suppressed by the prevailing organization of production. Only after slave emancipation in 1848 and the resultant crisis of plantation agriculture did it play a significant role in colonial economic life (Daubrée 1841: 31-35; Généralités, 56[543]; Sainte Croix 1843: 58; Tomich 1990).

NOTES

1. Material for this article is drawn from my forthcoming book *Slavery in the Circuit of Sugar: World Economy, French Colonialism, and the Crisis of Plantation Agriculture in Martinique (1830-1847)*, (Baltimore, Johns Hopkins University Press, 1990), and appears with the permission of the publisher.

2. The argument for the incompatibility of slave labor and technological innovation in the sugar industry has been made most forcefully by Moreno Fraginals. In this interpretation, slaves are viewed as incapable of attaining the minimal technical level required to operate complicated machinery, and the introduction of free wage workers was necessary to modernize production. (Moreno Fraginals 1976: esp. 40-41, 112-113, 144) Against this technological determinism, Rebecca J. Scott has documented for Cuba the high number of skilled slaves performing technically advanced jobs and the dependence of the largest and most mechanized plantations on slave labor (Scott 1985: 3-41, 84-110). See also Boomgaard & Oostindie in this issue.

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COMMENTARY: THE SEARCH FOR A UNIFIED FIELD THEORY

The conference sessions of which the foregoing articles are the fruit were dedicated to the discussion of the interrelationship of changing labour systems and technologies in Caribbean sugar plantations between 1750 and 1900. What made the exercise frustrating and incomplete as well as challenging and important was that it clearly involved many more variables besides those of labour and technology. However widely labour and technology are defined, at least five other related and intertwined factors have to be considered: the availability and suitability of land; the supply of capital; the access to markets and market prices; management strategies, attitudes and personnel; and finally, changing economic policies – specifically those designed to speed the transition from narrow mercantilist units to a world-wide “free trade” system.

In seeking a causal explanation for the complex process of change in Caribbean sugar plantations over 150 years, we are all surely seeking the simplest possible key; what might be called – if the pun be pardoned – a kind of unified field theory. But besides making sure that we leave out of consideration none of the obtruding factors mentioned above, we must surely not look at one place or area in one time period, but at the whole region over the whole period of global changes.

As for special comparisons and interrelationships, we have gone some way, but probably not far enough. It is not enough to seek similar processes in different places over different time scales; we should seek to show how developments in one area led to, or related to, developments elsewhere, and how all related to global developments. This may seem a crass commonplace; but nonetheless ignoring it does seem to be the root of some of the confusions, for instance, in the “Williams-Drescher” debate, as well as in some of our own labour: technology discussions.

For example, what was true about the relative importance of economic and humanitarian arguments in the 1780s was surely very different from arguments under the same heads after the British slave trade was abolished in 1807. And what might be felt about the relative efficiency of slave versus free wage labour and the value of technological innovation before slaves were emancipated anywhere and industrialisation had not anywhere gone far, was surely very different from labour: technology considerations once the slave trade had ended and technological changes were ever more widely available.

There are also the questions of reasons versus chance or contingency in the quest for optimisation. We have to decide in a given case whether planters did what they knew or thought was best, or what was the best alternative actually open to them; or whether they did what they thought was best and were proved to be wrong; or whether they optimised rationally under certain conditions and were overtaken by events and developments that were unforeseen.

We could carry on this line of relativistic and hypothetical argument *ad infinitum*. But let us turn instead to a more relevant issue. How well have we in the foregoing articles answered some of the questions posed, or reaffirmed or refuted some of the claims made, in the initial position paper written by Peter Boomgaard and Gert Oostindie (1989)?

Firstly, was slavery inefficient (as well as unjust) as the abolitionists argued? In other words, were slaves under any circumstances more productive than other forms of labour? Were slave plantations ever more profitable than the same plantations might have been with "freer" forms of labour, given that such were freely available? Secondly, was slavery incompatible with technological change, sustaining a conservative class of owners and retarding progress, as Marxists aver?

Broadly, I take it, Boomgaard and Oostindie's answers to both questions were "No". But what of areas where slavery did continue because the quest for profits seems to have called for it to do so, at least for a time, as in Puerto Rico and Cuba, as well as in Brazil and the United States? Were these forms of slavery really the same as those that had expired? Or were the alternative labour systems loosely called free – indentured "coolies", part-time peasant labourers, migrant workers bound by debt peonage or other forms of constraint – really no more than slaves, as Michiel Baud (1988) seems to argue? And were the levels of technological change or innovation under formal slavery itself of which several authors, notably Richard Sheridan (1989), have written, really as substantial as those that came after slavery ended – whether or not emancipation was the only reason or not?

Other less central questions put forward by Boomgaard and Oostindie have surely been aired, though not finally solved. These include, thirdly, the question of the relative abundance of available labour; fourthly, the importance of the periodicity of labour demand during slavery and after; fifthly, the role of slaves' and other workers' resistance to plantation labour, or, in particular, of all workers to cutting cane; and sixthly, the significance of tariff barriers, or their lack, in the establishment and maintenance of sugar prices, and thus of the levels of profitability.

We have all surely come away with fresh or reinforced ideas about these, and perhaps many other questions. Other differential factors which have occurred to me since include the significance of the great variations in the growing cycle of sugar cane and thus the length of the cane cutting season, between areas with very marked winter and summer seasons and those like Guyana where cane could be planted at almost any time of year and harvested almost continuously; of the difference between mixed cane farming systems based on the Brazilian counterpoint between share-cropping *lavradores* or *colonos* and true plantation slaves, and the more intensive monolithic slave labour systems preferred by the Dutch, British and French; or of the special "cultural" conditions that allowed a colony like Barbados to expand its sugar production to a peak after slavery ended without the availability of virgin land, without notable economies of scale or even substantial technological change.

My own chief feeling, though, is that the best place to look for firmer answers to the questions posed, is in the words and writings of the planters themselves – those with greater personal experience, and with more personal interest, than we as contemporary historians can ever have. The article I would have liked to offer at this time had I the time to write it would have been called "Worthy Park Revisited" – being a re-examination and re-evaluation of some of the material concerning a single Jamaican sugar estate which James Walvin and I studied and wrote about between 1968 and 1978 (Craton & Walvin 1970; Craton 1978).

In particular, I thought to look again at the three persons with very different characters and significantly different roles who gave evidence on behalf of Worthy Park in the 1848 Parliamentary Inquiry into the crisis facing the British Caribbean sugar industry. The hope was that each would provide a different facet of the problem of plantation management under changing conditions. First of these featured actors was George Price, fifth of six sons of the former owner, who had gone out to manage and revive the struggling family estate in 1843 at the age of 31 with an infusion of fresh capital provided by his father-in-law, Lord Dunsany. George Price made valiant but vain attempts to mechanise Worthy Park and reorganise

its labour force, mainly by offering competitive wages. He remained in Jamaica for more than 20 years despite the estate's economic collapse, an important figure in local politics and a resolute opponent of Governor Eyre. Second was Thomas Price, George's youngest brother (later, Lieutenant-Governor of Dominica and British Honduras), who had already been to Worthy Park in 1841 and returned in despair. As an absentee increasingly gifted with hindsight, he was a severe critic of what he regarded as his brother's "visionary" expenditure and mismanagement, unfairly blaming him for cutting off the family's Jamaican income. Third was Viscount Ingestre, Worthy Park trustee and mortgage-holder since 1835 by virtue of the last will of his brother-in-law, the father of George and Thomas Price. He now regretted the family connection which had led to such disastrous investment, bewailed the way in which his money was locked up, and would dearly have liked to deploy it elsewhere (British Sessional Papers 1848: 4963-5170).

The planned paper was not written, largely because the counterposed roles of the three *dramatis personae* did not come clearly enough through the written record. On a re-reading, most of the evidence given before the 1848 Commission was found to have been given by Thomas Price, who had far less direct involvement in the running of Worthy Park than had his brother George, and whose financial interest was less direct than Viscount Ingestre's. Yet the dozen pages of evidence presented to the 1848 Commission did touch on almost all the critical factors mentioned at the beginning of this essay and discussed in the foregoing articles.

Firstly, the evidence showed that at Worthy Park during the 1840s the availability of suitable *land* was not an immediate problem. Though the original estate had optimised its own cane lands since the 1790s, adjacent decayed or abandoned estates could be, and were, bought up for a song. Had the Prices been otherwise able to create a very large central sugar operation at Worthy Park, they would have been constrained in time by the surrounding mountains; in fact their enterprise failed altogether before suitable land ran out.

Secondly, *capital* was available to a degree, but what it could achieve was severely limited by labour and technical constraints. Thirdly, *technological modifications* were tried, but they failed for reasons unrelated to whether they could, or did, increase productivity. Fourthly, *labour* was a problem, but chiefly on account of the need to reorganise it efficiently into a two-tier system of a small corps of permanent workers and a larger seasonal cane-cutting gang, its availability *when needed*, and its *cost*. Fifthly, *imperial policy* was an extremely contentious issue, Thomas Price arguing that the economic situation might be remedied, if narrowly, if the imperial

government maintained the sugar price at ten shillings a hundredweight by subsidies, and if it subsidised the immigration of foreign labourers to allow the reduction of the daily rate of wages from one shilling and sixpence to twopence or fourpence.

But the bottom line, sixthly, was surely the *world sugar price*. This had reached a catastrophic low in 1846-7, so that even with optimisation and maximum production, Worthy Park's total income from sugar and rum was well below the cost of production. In existing circumstances the total income was actually less than the *wage bill* – quite ignoring all the other costs, including that of servicing the standing debt. Under such circumstances, it was inevitable that capital would migrate elsewhere, and even relatively fortunate Jamaican estates like Worthy Park would be forced to close.

What happened in the face of these and similar problems and crises? It depended, of course, on who you were and what were the options, if any, available to you. Firstly, the workers (whose role and behaviour are hardly considered in the foregoing articles) did what they could to find alternative work or ways of subsisting, or to obtain the best type of work and the best wages, and to shape and optimise and determine conditions as best they could by forms of industrial action or resistance.

Secondly, the planters and their managers did what they could to adjust and juggle and make new equations. These included changing field and factory practice as best they could, to get new capital if they could, to make technological changes as far as their knowledge and means allowed, to diversify (and here the comments about the moves towards coffee, cotton and, later, bananas are very apposite) and, in the last resort, to shut up operations altogether.

For those, thirdly, who provided the capital – absentee family members or associates like Thomas Price or Lord Ingestre, or faceless bankers – the options and strategies were different again. They might be satisfied with local attempts to adjust and reform the labour and technical systems, or to diversify, to cut back production temporarily, or to practise economies of scale as far as possible. But they were far readier than resident owners or managers to close down operations and switch elsewhere. In many cases they were only frustrated by the inertial provisions of the existing laws of inheritance, entail and bankruptcy, which made it practically impossible to dispose of “encumbered” estates until 1854 (Craton & Walvin 1970: 208-233).

These are the three main levels of human behaviour and practices. But we ought also to distinguish three, or even four, other more determinant levels on the material plane: those of individual plantations, of the larger

island or colony units, and of the Caribbean region as a whole – placed, of course, within the total world economy.

For itself, Worthy Park staggered on somehow as a sugar producer, until the years of stunning success following World War Two – though under several different owners. This story is written in *A Jamaican plantation* and *Searching for the invisible man* (Craton & Walvin 1970; Craton 1978). The island colony of Jamaica as a whole, however, almost ceased to be a sugar producer by 1900, becoming a rather more diversified but still desperately poor backwater, notable mainly as an exporter of migrant labourers at a time when capital migrated to sugar production in Cuba and banana plantations in Central America. Within the island, as Verene Shepherd has pointed out in a recent dissertation, cattle pens largely took over the best former sugar land, and the cattle pen owners turned themselves into, or became part of, what Douglas Hall and Verene Shepherd have termed a “penocracy” (Hall 1959, 1979; Shepherd 1988).

In the context of the wider Caribbean this points up a curious but significant development very relevant to our current discussions. Whereas Jamaica was one of the greatest sugar producers during the heyday of slavery, islands like Spanish Puerto Rico and Cuba, and other Spanish mainland colonies, were largely cattle ranches and small scale producers of minor crops. Once Cuba and, to a certain extent, Puerto Rico became great sugar producers, though, the positions were almost reversed, with Jamaica reverting to a largely ranching and peasant subsistence economy. Viewing this transition in the widest perspective, it was clearly a local function of an age that saw great developments in the internationalisation of capital, the spread of free trade and laissez faire principles, the worldwide organisation of transportation, processing and marketing, and, not least, the much more efficient organisation of migratory labour on a global scale (Moreno Fraginals 1978; Scott 1985; Zanetti & Garcia 1988).

Out of a reading of the foregoing articles and our discussions of them at the 1988 Americanists’ conference in Amsterdam, I make the following preliminary, tentative and personal conclusions. If we look for the *single* over-riding principle in the labour: technology equation or the sugar plantation debate at large, we cannot do better than accept the truism that sugar plantations are “ultimately in the business of making profits”. But beyond that, an only slightly less simple formula gives me slightly more satisfaction, at least for the time being: “Change (including technological change) was ultimately driven by the quest for profit in the face of the world sugar price. Change, however, was limited not so much by the availability of capital or labour as by the availability of plentiful, cheap, fertile and politically unencumbered *land* – since both capital and labour

would readily migrate or become available to such areas, and *only* to such areas."

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CHANGING SUGAR TECHNOLOGY AND THE LABOUR NEXUS: THE CARIBBEAN, 1750-1900

Between 1750 and 1900 revolutionary changes took place in the agricultural and processing technologies of cane growing and sugar production in the Caribbean.¹ The innovations that altered the entire processing structure are fairly well documented: the application of steam power, better cylinders, vacuum pans, centrifuges, double to quintuple effect evaporation, and – regarding the scale of operations rather than their nature – ‘usines centrales’. Important changes are also to be found in the sector that bridges the gap between cultivation and processing, i.e. transportation: movable rails, fixed rails often combined with steam traction, and conveyer belts. Finally, somewhat less well documented, we find a number of modifications in the agricultural sphere: new cane varieties; more (or less) ratooning, alterations in planting distances, ploughs, better drainage and irrigation, and the application of manure and fertilizer.

During the same period the social organization of Caribbean sugar production changed considerably, although not everywhere at the same rate or to the same degree. The slave trade and slavery were abolished throughout the region. Indentured labour, free seasonal labour, and free permanent labour were substituted for slavery or initially employed in addition to it. In a number of cases the ‘new’ (ex-slave) peasantry started to produce sugar as well. Often, two or more of these employment conditions coexisted in one country during several decades, which may very well have led to modifications within each labour mode, even though we still would call it by the same name (slavery). But even in countries where slavery was the dominant type of social organization of production until the very end, alterations in labour relations occurred, partly as a result of the adoption of ‘amelioration policies’ and concomitant new legislation.

Given these two sets of fundamental changes, the question might be

(and indeed has been) asked, whether there existed any concurrent connection between technological development and changing labour relations in the Caribbean. And if so, how far the timing of the one was determined by the development phases of the other.

In the historiography of the Caribbean two major schools of thought have formulated explicit ideas on this subject. The Abolitionists argued that slavery was an obstacle to efficient production because the availability of cheap labour had rendered the application of new, labour-saving techniques unnecessary. Slavery, therefore, had created a tradition-oriented class of planters.² Secondly, marxist historians often have argued that an advanced technology and the existence of slavery are incompatible. Complicated, modern factories cannot be operated with slave labour; slavery, so the argument runs, had to vanish before the sugar industry could become thoroughly modernized.

These notions have permeated the historiography of the Caribbean sugar industry in the nineteenth century. Over the last decades, however, several scholars have reconsidered the sugar technology – labour nexus more thoroughly, casting doubt on both the underlying assumptions and the empirical viability of the two older theses. Clearly these notions can do with some rethinking.

THE CONTEXT

The discussion of sugar technology and the labour nexus is often embedded in a broader context, namely the debate on the profitability and viability of slave labour as such. It may be useful to disentangle some of the issues at stake. First, the economic background of abolition is still hotly debated. Since the publication of Drescher's *Econocide* (1977), the historiographical orthodoxy seems to be shifting from the economic determinism of Ragatz (1928) and Williams (1944) to Drescher's thesis, namely that the abolition of the transatlantic slave trade was brought about by genuine abolitionist fervour, not by a preceding decline in the profitability of the slave trade and West Indian slavery.

Did the ending of the trade immediately result in declining profitability of slavery itself? Here too, recent debates have corrected some of the older economistic orthodoxies. It may be true that in the long run slavery without a replenishing slave trade to correct a usually negative demographic performance of the slave populations was not feasible or at least less profitable. Yet, recent research has contradicted at least the immediacy of a so-called age-related crisis of slavery. As Rebecca Scott (1985:91-7)

demonstrates, even the late abolisher Cuba did not suffer from an ageing and thus less productive slave force preceding emancipation. The same conclusion emerges from an analysis of the Puerto Rican slave population on the eve of emancipation (Nistál-Moret 1985:145). Higman (1976:212-26) does admit to an unfavourable change in terms of age and sex for the Jamaican slave population as a result of the abolition of the slave trade. Yet, he indicates that overall labour productivity did not suffer from this demographic set-back.³ Klein and Engerman (1985:267) even argue in more general terms that it "is doubtful that, in any major case, slave emancipation, however achieved, reflected a prior decrease in the profitability in the use of slave labor on the plantation. Broadly considered, emancipation usually came at times of expanding production, not stagnation."

Slavery, then, may not have been a decaying and obsolete institution in the decades preceding emancipation (Engerman 1986). It may be worthwhile bearing this in mind, since precisely the obsolescence and declining profitability of slavery are implicit corner-stones of the incompatibility-thesis. Moreno Fraginals (1985:4-5) for example situates the 'inevitable' transition to free labour in the Spanish Caribbean not only in a context of radical innovations in the sugar industry involving "highly sophisticated machinery that required skilled operators and efficient technical supervision", but also of a "crisis of the slave system" as such.⁴

The above indicates the broader context in which the innovation-cum-slavery debate is embedded. Some additional remarks may be appropriate in order to dismiss certain often raised issues which on closer inspection seem to miss the point.

First of all, there is a tendency to underestimate the level and diffusion of innovation actually achieved in the eighteenth- and nineteenth-century Caribbean, as will be demonstrated below. From this unjustified underestimation, it is but one step to 'successfully' establishing a link with planters' conservatism and/or the inherent incompatibility of slave labour and technological progress.⁵ Admittedly, in general terms the Caribbean mostly reacted to European inventions, not generating original contributions of its own. This, however, seems to be an unfair and ahistorical argument, as Europe, not any of the (semi-)peripheral regions of the world-economy, was the cradle of the Industrial Revolution. North-western Europe and later the United States determined the rhythm of innovations all over the world. Since neither Eastern Europe nor Asia, Africa or Latin America produced significant inventions, it is not surprising that the hardly urbanized and mineral-poor Caribbean did not do so either. Nor can we blame the

eighteenth century for being less inventive than the nineteenth. It seems untenable to attribute a major importance to the region's mode of labour here.

Metropolitan factors also significantly influenced the level and diffusion of innovation in the Caribbean. The availability of capital and technical know-how in the metropolis may be mentioned in this context, as well as absenteeism and the degree to which both the metropolitan government and West Indian interest groups in the metropolis stimulated the transfer of technologies to their Caribbean dependencies.⁶ An example may be useful here. The diffusion of innovations implemented in British Guiana's sugar industry in the three decades following emancipation undoubtedly compares favourably with the improvements realized during the same period in neighbouring Suriname, where slavery was upheld until 1863. Yet, on reading Adamson's (1972:167-77) analysis of British Guiana's technological progress, one feels that British capital and know-how (and the fact that Guiana was a 'new frontier') rather than the labour issue made the difference. After all, Suriname also faced acute labour shortages long before the abolition of slavery.

Finally, the actual profitability of the plantation sector determined the possibility of internally generating capital for innovative investments. Obviously, there existed crucial variations within the Caribbean as to these factors. Yet, whatever the different outcomes, all territories shared a predominance of slave labour well into the nineteenth century. Attributing their different records of innovation primarily to the mode of labour therefore seems highly questionable. In fact, it can easily be demonstrated that between 1833 and 1890 some slaveholding societies were characterized by profitable plantations, whereas other slaveholding economies were not. The same is true of non-slaveholding societies, of which some could boast of a profitable plantation sector, and others not.⁷

CONSERVATIVE SLAVEHOLDERS?

This being said, we may now turn to the heart of the matter. The debate will be separated into two related questions. First, did low levels of invention/innovation characterize slave-holding plantation economies, and if so, can this be attributed to the presence of a large, relatively cheap labour force rendering superfluous all attempts to introduce innovations? Second, we will examine the proposed incompatibility of slave labour with technological innovation in more detail.

The planters' traditionalist outlook and their refusal to innovate often have been cited as one of the causes of West Indian economic decline (Green 1973:448; Green 1976:51; Knight 1978:125; Watts 1987:391). Sometimes this attitude has been linked to one or two factors typical of West Indian sugar producers: they had access to a cheap supply of labour (slaves), and the leading sugar colonies produced their sugar behind the comfortable walls of a protective sugar tariff. The cheap labour argument, which is our main concern here, often has been formulated in a 'disguised', implicit form: labour saving innovations had to be introduced after abolition and emancipation, because 'free' labour was more expensive (Mintz 1986:69; Parry and Sherlock 1971:198). In this section we shall try to determine if the West Indian sugar planters indeed did refuse to innovate, and, if so, whether this can be attributed to cheap labour.

A glance at the number of inventions/innovations shows that it cannot be said that the technology of sugar production remained unchanged between 1640 and, let us say, 1840 (Deerr 1949, II:536-52; Green 1973; Green 1976:52-7; Watts 1987:383-446). Planters continually adapted the original Pernambuco 'model' (Watts) when the cultivation of cane spread from Brazil to Barbados and from there to other West Indian islands: the Barbados model.⁹ They also soon grasped the need for alterations when ecological conditions in the islands deteriorated, or when profit margins were falling, particularly after 1750. For a detailed treatment of these changes, both in the agricultural and in the processing stages of sugar production, the reader is referred to David Watts' recent study on the West Indies (Watts 1987).

Nevertheless some doubt remains. The question could be asked whether the planters, given the available examples of 'modern' agricultural and industrial practices elsewhere, could not have innovated more than they did. Also, it is worthwhile to try and find out which part of the innovations that were introduced can be regarded as labour-saving ones, as one of the traditional explanations for the lack of innovation emphasizes cheap labour, and therefore the absence of the need to introduce labour-saving devices.

Did the planters innovate as much as they could have done? It can be said that the West Indian planters did not copy all Western European, particularly British, innovations which taken together often are referred to as the Agricultural Revolution. Watts (1987:446) mentions animal husbandry as one of the important elements in eighteenth-century British agricultural improvement that was largely neglected in the Caribbean.¹⁰

Another remarkable 'oversight' of the planters was the use of the plough. This at least has often been suggested. Yet the story of the plough in the Caribbean is a good example of the complicated nature of the problems we are dealing with. In general terms it is quite clear that the use of the plough instead of the hoe is a labour-saving innovation. Several factors, however, militated against using the plough in the West Indies. The rather shallow topsoil was much more subject to dehydration and erosion than the heavy European soils, while steep slopes and soils were too stony for the plough. Next, the presence of many drains and canals in 'polder'-like areas such as Suriname and British Guiana inhibited ploughing. Finally the absence or high price of strong draught animals proved to be an obstacle.¹¹

The question, therefore, may be asked whether introducing the plough in the West Indies was really such a good idea, given the adverse natural circumstances.

In addition, many plantations followed a practice called cane-holing, which could not be applied by using a plough only. Here the slaves still had to use the hoe after ploughing, which restricted the amount of labour saved with the plough. Even in the Dutch East Indian colony of Java, where the plough had been used since time immemorial, the introduction of the system of cane planting developed by the Cuban agronomist Reynoso, caused a switch from plough to hoe in the sugar districts around 1870 (Sollewijn Gelpke 1885:107).

These adverse circumstances notwithstanding, in several Caribbean islands the planters, after 1770 hard pressed for cost-cutting innovations, did experiment with the plough but found it wanting. After several decades most came back to the hoe (Watts 1987:429-32). Yet after emancipation, many planters once again reverted to ploughing, presumably because the need for labour-saving devices by now had become of paramount importance (Craton, Walvin and Wright 1976:333; Green 1976:205-6; Parry and Sherlock 1971:198).

The story of the plough suggests that at least some planters were interested in cutting costs, that they were aware of the advantages and disadvantages of certain innovations, and that they were prepared to experiment with 'novel' practices even in the face of serious obstacles. It might be interesting to investigate the use of the plough after its post-emancipation reintroduction.

Given the complicated nature of any innovative process (of which the varying fortunes of the plough in the West Indies are only one example) it might be worthwhile to direct research towards similar 'oversights'.

A further question is which part of the introduced innovations can be regarded as labour-saving, in contrast to innovations such as the introduction of iron and horizontal rollers or higher yielding cane varieties (Otaheite, Bourbon) which were not aimed at reducing labour input, but rather at an increase of the productivity per acre of cane. Watts (1987:384) distinguishes between the period 1665-1720, when most innovations were related to ecological deterioration, and the period after 1750, when in response to increased competition and rising costs planters attempted to increase efficiency. Perhaps we should concentrate on the latter period in our search for labour-saving innovations.

The plough was, of course, intended as a labour-saving innovation. So were the repeated attempts to increase the number of ratoon crops (more harvests from one cane plant). Another example was the introduction around 1755 of the so-called 'doubleuse' or 'dumb returner', "an iron shield which caught the once-crushed cane on the far side of the mill rollers from ingress, and turned it into a position for automatic re-entry back into the rollers for a second crushing" (Watts 1987:420).¹² In all these cases the primary motivation of the planters was to cut costs by substituting capital for labour or by reducing the number of labour-intensive operations.

In all probability this was also one of their motives for experimenting with steam-mills from the 1770s onward (Debien 1941:75; Deer 1949, II:549-52), though for a time experiments came to naught. It is less clear whether the planters realized that steam-mills could only be operated at a profit if used to their full capacity. Full capacity however required a larger input of cane and therefore more labour in the field!¹³

A next issue is whether slaves can be regarded as cheap labour and therefore as a disincentive to the implementation of labour-saving innovations. A first off-hand comment to this supposition is that the price of slaves did not remain unchanged during the two centuries between 1640 and 1840. Pares (1960:38) states that the prices of slaves more or less tripled between 1660 and 1790. Prices continued to rise subsequently, particularly after the abolition of the slave trade. So even if this argument may have been valid in the late seventeenth and early eighteenth centuries, it is highly unlikely that it is also applicable to the late eighteenth or early nineteenth centuries.¹⁴

The question is, however, more complicated. Various authors mention that the number of slaves required on a sugar plantation was not determined by typical agricultural activities, but "by the extraordinary demand for labour during the harvest season when sugar was cut, milled, boiled, cured,

packaged, and transported to port" (Green 1973:449). Outside the milling season the available labour force was not fully needed and, so the argument runs, had to be kept occupied (Pares 1960:23; Sheridan 1960:139).

This generally held belief among historians implies that one busy season for which a minimum number of slaves had to be acquired characterizes the sugar plantations. Labour-saving innovations for activities outside the milling season, when part of the labour force was apparently redundant, were therefore not needed. For a number of reasons this line of argument is not entirely satisfactory, and a closer look at plantation labour requirements seems necessary.

Case studies on Surinam sugar plantations suggest that these plantations did not have only one milling season. Cutting and milling cane could be done throughout the year, and a prudent planter might have hoped to avoid an extraordinarily busy period at the mill by staggering his planting and thus his harvest.¹⁵

Moreover many Surinam plantation records indicate that the maintenance of buildings, fences, and ditches was in arrears. This state of affairs implies that labour outside the milling season was far from redundant. Suriname may not have been exceptional as far as these two examples are concerned, and it might be worthwhile to look for similar evidence from other Caribbean areas. In fact, Scarano in his analysis of a Puerto Rican sugar county explicitly contradicts the notion of a dead season as opposed to the harvest time: "the intensity of work did not diminish noticeably during the off-season; rather, workers employed in industrial tasks were transferred to the fields to prepare the canes for subsequent harvesting" (Scarano 1984:102).

Finally, even though the milling season might have been a peak period in some plantation areas, it was not the only one. Planting cane, particularly in those areas where the caneholing system had been introduced, was tedious and hard work. "The work was so laborious and exhausting [...] that selfinterest alone prompted most overseers to seek assistance for their slaves by hiring a jobbing gang" (Patterson 1976:66). This quotation merits our attention for more than one reason: not only does it demonstrate that it would be erroneous to regard all activities outside the 'campaign' as the slack season, it also draws our attention towards a phenomenon often overlooked in discussions on Caribbean labour supply and demand under slavery: the jobbing gang. The existence of jobbing gangs implies a much greater flexibility in the supply of labour during peak activities than has been assumed by scholars equating the minimum number of slaves needed for a sugar plantation with the minimum number needed during the harvest. One should establish how often and for which kind of activities plantation

owners hired jobbing gangs, instead of just assuming that as far as labour was concerned the plantation was a closed system.

Taking all the evidence together there seems therefore to be ample room for questioning the validity of the abundant labour supply thesis.

SLAVE LABOUR AND TECHNOLOGICAL PROGRESS

Europe's Industrial Revolution emerged in a free wage economy where bonded labour had disappeared. With the diffusion of modern technology and the Western economic system over the world, in the long run bonded labour was also elsewhere increasingly combined with, and subsequently replaced by, free wage labour. This historical connection between industrial progress and free labour has led many scholars to posit a causal relation between the two. The conclusion with regard to the Caribbean would be obvious then. Free wage labour replaced slavery as the latter was incompatible with the growing demands for skilled labour concomitant with the 'mechanization' of Caribbean sugar production.

Contemporaries sometimes posited an incompatibility of slave labour with technological progress with reference to the supposedly backward, lazy, unreliable etc. nature of the slaves - in short, in terms of the contemporary racist ideology.¹⁶ Others blamed the system of slavery for degrading the slaves, the slaves' incapacity to adjust to innovation thus being the result of a regime of repression and a lack of incentives, not of any personality traits. Small wonder that only the latter interpretation has survived in modern scholarship on the Caribbean. An early example of this is to be found in Williams' 1944-classic *Capitalism and slavery*: "The labor supply of low social status, docile and cheap, can be maintained in subjection only by systematic degradation and by deliberate efforts to suppress its intelligence. Rotation of crops and scientific farming are therefore alien to slave societies." (Williams 1981:7).¹⁷ Perhaps the most prominent recent protagonist of the incompatibility-thesis is Moreno Fraginals. Analysing innovation in the Cuban sugar industry in the 1840s, he maintains that "the new machines were too complicated to be operated by slaves. [...] The industrial revolution implied the transition to the wage labourer."¹⁸ In another, more recent reflection on the same issue he situates the crisis in the 1860s rather than in the 1840s. Yet, the arguments are similar (Moreno Fraginals 1985:4,15-6).

Although few would disagree that in the long run slavery is indeed an anachronism in a world of sophisticated technology, strong arguments have been put forward to counter the relevance of the incompatibility

issue in a nineteenth-century Caribbean context.¹⁹ Broadly speaking, there are two lines of argument intertwined in the literature.

First, some scholars have contradicted the incompatibility thesis by demonstrating that some of the countries clinging for the longest time to slavery were technologically among the most advanced Caribbean sugar producers. Cuba is a clear case. Abolishing slavery only in 1886, half a century after the British West Indies, Cuba became the pinnacle of technological accomplishment among the Caribbean sugar producers from the 1820s onwards, slavery apparently notwithstanding. Recently, Scott has produced even more devastating evidence against the incompatibility thesis by demonstrating that even within Cuba there was a positive, not a negative, correlation between the predominance of slavery and technological innovation. Thus, in the 1860s, the technologically most advanced sugar producing regions were precisely those where slavery was dominant and, eventually, held out longest; even in the 1870s, Scott concludes, "where sugar prospered, slavery persisted" (Scott 1985:87, also Scott 1984:87-9, Bergad 1989). Consequently, she explicitly challenges Moreno Fraginals' view of a conservatism necessarily linked to slaveholding. On the contrary, the most technologically progressive planters clung tenaciously to slavery while also employing other types of labour simply because not enough slaves were available to them. The resulting mixture of types of labour may be interpreted as a sign of the slaveholding planters' flexibility instead of rigidity (Scott 1985:91).

The second line of reasoning centers on the nature of work on sugar plantations and on the competence of slave vs. free labour to perform qualified tasks. As to the nature of work, though the overall low qualification of work entrusted to plantation slaves is not debated, various authors emphasize that on every slave plantation slaves performed some qualified labour. This 'slave aristocracy' of skilled artisans traditionally consisted of sugar boilers, drivers, carpenters and other craftsmen. Their levels of skill must have been considerable according to contemporary standards. From our own research on Surinamese plantations we found abundant evidence of slave children serving years of apprenticeship either on the plantation or in the city of Paramaribo before being entrusted with qualified positions within the hierarchy of the slave work force. Similar evidence on skilled slaves is recorded in studies on other Caribbean slave plantations.²⁰

The obvious next question is whether technological innovation indeed occasioned a demand for labour that could not be met by qualified slaves. The evidence on this matter seems inconclusive. Clearly most of the

sophisticated apparatus installed on nineteenth-century plantations needed the supervision of technical experts. Incidentally, these engineers were mostly recruited from Europe or the US, implying that it was their previous experience with modern technology, not their being free instead of slave which made the difference; after all, some free labour as such would have been available within the colonies too. Moreover, quite some evidence has been put forward on slaves actually working with modern technology (Scott 1985:26-7; see however Heitmann 1987:38-9).

A further test of the incompatibility thesis would be to establish whether alternative forms of labour were indeed intrinsically better equipped to perform the qualified tasks demanded by the new technologies. Foreign engineers certainly were; yet engineers formed only a tiny minority of the labour force.²¹ After Emancipation (in the Cuban case also in the preceding decades) indentured labour from Asia was imported to add to the labour pool. It seems highly debatable whether the Chinese in Cuba, the East Indians in Trinidad or the Javanese in Suriname, often with no educational background and scarcely any on-the-job training, would be better equipped than slaves to perform qualified tasks. This reasoning applies *a fortiori* to the freedmen themselves; one wonders if a change in their legal status really made them more intelligent and dedicated craftsmen from one day to the next.

Perhaps the most serious objection to the incompatibility thesis raised in this context is whether the technological innovations in the sugar production throughout the eighteenth and nineteenth centuries really resulted in a significant qualitative change in labour demand. It may well be that innovations in sugar processing provoked a change in demand for skilled labour; whether slaves were intrinsically incompetent to perform these new tasks has been discussed above. But whatever the answer to that question, a more fundamental query remains: did innovation really affect more than just a few jobs, and hence was it really of any significance for the average plantation's labour demands?

Strangely absent in most writing on the topic, this query seems to raise serious doubts about the incompatibility thesis.²² Whatever the innovations introduced in the eighteenth and first decades of the nineteenth centuries, they coincided with the dominance of slavery. The innovations implemented subsequently in a context of slavery-on-the-retreat were situated primarily in the processing stages of sugar production. This left field work to the old routines; even where manuring and other agrarian devices were implemented, this did not entail the use of elaborate machinery in the cane fields. Consequently, it may be argued that the bulk of labour on

Caribbean sugar plantations continued to be performed by field labourers throughout the nineteenth century. It seems that the nature of this fieldwork did not change much in the period from the seventeenth-century establishment of the Barbados model, to borrow Watts' (1987) phrase, until the twentieth-century mechanization of cane-cutting.²³ If so, it would be difficult to maintain that slavery had to be abolished in the nineteenth century because of any significant change in the labour demand of the Caribbean plantation.

At this stage of our research, our knowledge of the extent to which job demands on Caribbean plantations actually changed as a consequence of innovation is limited. Yet precisely this aspect should be explored before we can conclude more confidently whether or not slaves were able to perform these tasks, whether indentured labourers or freedmen were actually performing significantly different work routines, and so forth.

Incidentally, a focus on the changing nature of labour demands and qualifications in the Caribbean sugar industry may indirectly also enhance our understanding of the social history of Caribbean slavery. If innovation indeed changed the nature of plantation work, then one would expect those affected to have responded to these changes. If only job qualifications in the higher echelons of the slave hierarchy changed, it would not be surprising to find a kind of artisanal protest of formerly privileged slaves comparable with the Luddism of early industrial Europe. Some authors have indeed given examples of slaves' protests against innovation. Green (1973:451) for instance cites the desperate comments of the Jamaican planter Lewis (1834), who in vain tried to economize on labour by introducing the plough: "the awkwardness, and still more obstinacy, of the few negroes, whose services were indispensable, was not to be overcome: they broke plough after plough, and ruined beast after beast, till the attempt was abandoned in despair". In a later publication, Green (1976:52-7) gives more evidence of slaves' sabotage of modern machinery. He attributes this to a firm resistance among the slaves against changes in "either the tools or techniques employed in West Indian agriculture".

If we were to find more general evidence of such an attitude, we would be obliged to admit to more than a kernel of truth in the argument that the nature of slavery was incompatible with innovation. The argument would have to be given an elegant twist though: it was not the slaves' inability – through lack of education rather than by nature – but their conscious resistance which impeded adequate innovation. This argument then would even serve to attribute diminishing plantation profitability at least partly to slave resistance to change.²⁴

Innovation may also have had profound effects on the plantation work force as a whole. Perhaps, as argued above, this was not the case in terms of overall labour qualifications. It may not be ruled out though that new technology did change work loads across the board. Thus, as has been mentioned above, the introduction of the steam mill and subsequent processing innovations, while diminishing the work load at the mill, increased the demand for cane. This demand for more cane may have been translated into a more intensive exploitation of slave field labour.²⁵

Generalizations as to the influence of innovation on the slaves' work loads seem difficult to make. It may be a rewarding line of research though to try to determine slaves' (and, perhaps, freedmen's and indentured labourers') responses to technology-derived changes of work patterns and loads.

CONCLUDING REMARKS

No doubt the very issue of the links between the 'peculiar institution' and the level of modernization of the Caribbean sugar industry derives much of its relevance from the direct consequences of this debate for the larger question of the explanation of the abolition of slavery. Clearly the incompatibility thesis fits nicely into an economic explanation of abolition, whereas denying incompatibility squares with 'econocide', or at least with refuting that slavery had already exhausted its possibilities at the time of its abrogation.

In the foregoing, several aspects of the debate came up for discussion. In addition to providing information on the level of innovation actually achieved (often underestimated in the literature), we have discussed both planters' and slaves' behaviour and the rationales underlying both. In doing so, we have dealt with a number of ongoing debates and suggested specific topics for further analysis regarding the structure and development of labour conditions. If such a research programme were to be carried out, it may be expected to enhance our understanding of the social history of Caribbean labour.

The considerations presented in this article, based as they are mostly on a re-analysis of known facts rather than new research, do not lead to any firm conclusions. Nevertheless it is appropriate to conclude with some suggestions for a re-examination of the issues involved.

Regarding the period before abolition it can be said that planters have shown more 'innovativeness' than they are usually credited with. Insofar as they could have adopted more innovations than they actually did, this might have been related more to tariff protection than to cheap labour.

That takes us back to the question of whether, indeed, high tariff barriers constituted a disincentive to innovation (Craton, Walvin and Wright 1976:294-5). Here at last we do have an argument that cannot be refuted easily. Even if one might be inclined to defend protection for an industry that in its early stage of development has to compete with older, established industries elsewhere (the infant-industry argument), continued protection for a mature industry with a sizeable share in the market tends to create a lazy entrepreneurial class, hardly noted for its innovative zeal.

Turning to the period after 1800, it may be, in the end, that the partial concurrence of the rather abrupt innovations in the nineteenth century with the abolition of slavery was hardly more than coincidental. In fact, many authors argue that the most crucial change since the seventeenth century was the emergence of the central factory, disconnecting the agricultural and the processing stages of sugar production (Engerman 1983, Moreno Fragonals 1985). If so, it should be brought to mind that several of the factors which facilitated this minor revolution had nothing to do with the Caribbean as such.

A final word of caution may be called for. In this article we have taken another look at a number of arguments often brought forward in connection with the slavery - innovation debate. We have not been trying to formulate a 'unified field theory'²⁶, explaining the varying fortunes of the Caribbean between 1750 and 1900. Such a theory should not be restricted to labour and technology only. It should also take account of variables such as availability and quality of land, availability of capital and credit, and the role of management strategies, market fluctuations, imperial economic policies, and global shifts in supply and demand.

Furthermore, we have not attempted to answer the tricky question whether 'free' (i.e. non-slave) labour was really free. Clearly it could be argued convincingly that various labour systems, such as debt peonage and indentured labour, are in fact not much more than the continuation of slavery with other means and under another guise. In this article we simply have dissected the arguments as used in the literature, and found them wanting in many respects.

NOTES

1. We should like to thank Dr. Rosemary Brana-Shute who kindly suggested various editorial corrections.

2. Clearly this argument is linked to the liberal ideology as expressed in Adam Smith's *Wealth of Nations*: "the work done by freemen comes cheaper in the end than that performed by slaves" (Smith 1976,I:99). Also: "the work done by slaves, though it appears to cost only their maintenance, is in the end the dearest of any. A person who can acquire no property, can have no other interest but to eat as much, and to labour as little as possible." (Smith 1976,I:387). Smith reasons strictly along economic, not racist lines. Thus the inferiority of slave labour is further attributed to the management "by a negligent master or careless overseer" and the master's hostility to any innovative proposal advanced by a slave (Smith 1976,I:98, II:684).

3. Van Stipriaan (this issue of *NWIG*) proposes a slightly contradictory conclusion.

4. Tomich (this issue of *NWIG*) defends a similar position: "The closely integrated technical organization of sugar production and the need to maintain the balance between its various elements, including labor, gave internal solidity to the sugar plantation and made it resistant to change".

It may be argued that the question whether free labour was preferable to slavery is simply beside the point, or at least anachronistic. As long as there were no real alternatives in terms of an ample supply of local free labour, Caribbean planters simply had to rely on imported bonded labour. No wonder then that planters in declining colonies such as Suriname clung just as tenaciously to slavery as their more prosperous colleagues in booming Cuba.

Both Scarano and Baud discuss problems of labour recruitment. The former indicates that in late eighteenth-century Puerto Rico, slavery was but one strategy to secure plantation labour; an alternative strategy was to deny free rural dwellers opportunities for independent farming, forcing them to accept plantation labour and thus trying to overcome the stalemate of 'mucha gente, pocos trabajadores' (Scarano, this issue of *NWIG*). Baud, in contrast, discusses the ways in which an abundant supply of labour from Haiti and a degree of technological innovation even "provoked new forms of unfree labour" (Baud 1988:13), and continues to do so in the Dominican sugar industry.

5. Both Emmer (1988:3) and Ward (this issue of *NWIG*) emphasize the considerable rise in productivity achieved in the Caribbean sugar industry during the period of slavery.

6. The significance of absenteeism clearly merits further research. For instance, Craton and Walvin (1970:120) state that 'absenteeism was the most notorious of all the burdens laid upon the West Indian estates'. Yet Sheridan (this issue of *NWIG*) links efforts to reform the British West Indian sugar plantation during the third quarter of the eighteenth century with growing absenteeism.

7. In his thorough analysis of the sugar industry in Pernambuco (1840-1910), Eisenburg makes several points of relevance to the issue at stake here, particularly in reviewing the traditional arguments concerning the presumed obstacles to technological innovation imposed by slavery. As the author indicates, the labour market situation in this Brazilian sugar producing region contrasted fundamentally with the Caribbean. In Pernambuco, an abundant supply of free wage labourers enabled the planters to make a smooth transition from slave to free labour, even lowering overall labour costs. Frequently, Eisenberg emphasizes that various factors account for the technological backwardness that characterized Pernambuco sugar production until the 1870s. Yet he seems to attribute particular importance to low labour costs under slavery as an obstacle to innovation. A comparison of this circum-Caribbean

sugar industry with mid-nineteenth century Cuba eventually leads him to the surprising conclusion that an abundant labour supply was a liability rather than an asset: "The happy combination of fertile land, scarce labor, and available capital allowed Cuba to lead the world in modernizing its cane industry." (Eisenberg 1974:219; see also 41-4, 217-9, 228).

8. For a discussion on post-emancipation labour costs in Suriname, see Höfte 1987.

9. To cite but one case in point, the choice for various, in certain colonies successive sources of energy is an indication of planters' flexibility. See f.i. Van Stipriaan (this issue of *NWIG*).

10. See however Sheridan (this issue of *NWIG*) on the introduction of Guinea grass (for fodder) as an important innovation introduced in Jamaica.

11. See Aufhauser 1973b:39-40; Green 1973:449-51; Pares 1960:23, Watts 1987:429-32 and particularly the contribution of J.R. Ward to this issue of *NWIG*.

12. Van Stipriaan, in this *NWIG* issue, mentions the dumb returner too, but in a nineteenth-century context. If Suriname indeed was that late in introducing this apparatus, this is an indication of the colony's backwardness. With labour as such this need not have anything to do: both Suriname and the British West Indies used slave labour.

13. Under favourable circumstances, a merger between adjacent plantations, producing cane for one steam mill only would be an alternative solution to the supply problem.

14. See for instance Van Stipriaan and Ward, both in this *NWIG* issue. Also Oostindie 1989:96, 120-2, 234, 245-6.

15. See Oostindie 1989:38-40 and Van Stipriaan (this issue of *NWIG*). There seem to have been clear chronological and regional divergences as to optimal planting and harvesting cycles. Not only the availability of labour, but also climatological and agronomical factors have been at work here. Clearly the 'dead season' was not as general, perhaps not even as optimal, as many authors have it. See Baud(1988:2), Scott (1985:24) and Sheridan (this issue of *NWIG*) for positive conclusions as to one harvest season, against, in addition to Scarano (1984:102), Van Stipriaan and Ward (this issue of *NWIG*).

16. Irony has it that in the Mexican sugar industry black slaves, in preference to the indigeneous Indian population, were entrusted with qualified positions on sugar plantations. Admittedly, an order of 1599 prohibiting the use of Indians in the mill or boiling house was of influence here. Yet, as Barrett indicates, "Negro slaves were capable of becoming skilled workers - smiths, cartwrights, and sugarmasters - and many did so [...]. It is true that fewer Indians assumed these positions of responsibility." (Barrett 1970:99; also 78-80 and 97-9).

17. Sheridan (1960:130), in an article on the highly innovative Antiguan sugar planter Samuel Martin, depicts the newly arrived African slaves in rather bleak terms ("crude, clumsy, and unintelligent by modern standards [yet] adaptable to the simple, routine methods of tropical agriculture"). A minority however is said to have "possessed the intelligence and manual dexterity to learn skilled crafts". The author does not link these assessments to a perceived inability of slaves to cope with innovation.

18. Moreno Friginals 1978,I:220 (our translation); see also II:29. A similar position is maintained by Genovese (1967:48-51) in his analysis of the economy of the US slave South. See also Mandle (1982:48-9), who even claims that a plantation economy was by definition incapable to be innovative.
19. The thesis of a fundamental incompatibility of slave labour with innovation in pre-modern Europe is also under attack; see Davis 1984:31-2, 326-7.
20. Craton and Walvin 1970: 111, 139-41, Debien 1941, Dunn 1987, Moreno Friginals 1978, II:36, Nistal-Moret 1985:155, Oostindie 1989:100-7, 113-6, 237-43, Patterson 1973:57-65, Ramos-Mattei 1985:172, Scott 1985:97-8, Sheridan 1960:131 and 1974:115, Van Stipriaan (this issue of *NWIG*).
21. See Van Stipriaan and Tomich (this issue of *NWIG*).
22. See however Aufhauser 1973 a and b. Not only does he refute the presumed incompatibility between slavery and technological progress; he even goes as far as claiming that the plantation slaves' work was comparable in many ways to the work regime according to Taylor's principles of scientific management in early twentieth-century American industry: "Instructions to [plantation slaves'] overseers read like Taylor's directions in the Midvale Steel Company" (Aufhauser 1973a:816).
23. Indeed, Scott (1985:228) observes that "[r]eturning to, or remaining on, the plantation as an agricultural worker often meant continuing the same kind of labor, under the same direction, that one had experienced as a slave". She also questions the emergence of an *apartheid*-like segregation of black freedmen in the field as against whites in mill work.
24. Yet, in his account of the immediate post-emancipation period, Green (1976:196) claims that sabotage and negligence increased. This would obviously weaken the incompatibility argument.
25. Lammens 1982:148; Moreno Friginals 1978,I:214, also II:27-9; Teenstra 1835,I:224.
26. This felicitous phrase was one of Michael Craton's contributions to the discussion during the Amsterdam seminar in July 1988. See also his contribution to this issue of *NWIG*.

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CONGREGATE AND CONTROL: THE PEASANTRY AND LABOR
COERCION IN PUERTO RICO BEFORE THE AGE OF SUGAR,
1750-1820

More than forty years after the publication of Eric William's *Capitalism and Slavery*, the study of transitions in modes of labor exaction, or more precisely, of passages into and out of slavery, remains at the core of historical writing on the Caribbean (Williams 1944; Solow and Engerman 1987). Prompted by Williams' stirring formulation of the West Indies' role in the development of Atlantic civilization, and inspired by the boom in slavery studies in the United States and elsewhere, students of the Caribbean have eagerly embraced the study of the rise and decline of the region's slave systems. While much of the scholarship on these issues refers, for obvious reasons, to the English- and French-speaking nations, scholars have paid considerable attention to the Spanish-speaking countries as well (Moreno Fraginals 1978; Scott 1985; Moreno Fraginals, Moya Pons & Engerman 1985; Scarano 1984; Paquette 1988).

Studies on Caribbean slavery stand on firm grounds, of course. Issues of great regional and national significance are at stake in the debates surrounding unfree labor: the peopling of the region by a massive forced migration from Africa; the perverse economics of the plantation system; colonialism and its heritage of neocolonialism and dependence; the segmented social, racial and ethnic milieus fashioned during the European conquest and colonization, and reinforced by successive migrations of different types across centuries; and many other vital contemporary problems. At the very least, then, the abundant slavery scholarship on the Caribbean can point to an impressive political achievement for, having flashed a mirror on the Caribbean past, it has vividly captured images and reflections that embody some of the region's most pressing problems, as well as some of its greatest promises.

It is apparent, however, that the discussion on slavery has overshadowed various noteworthy aspects of the history of Caribbean labor. This is especially true for the Spanish-speaking colonies of Cuba, Santo Domingo, and Puerto Rico. These countries, as is well known, did not tread on the slave plantation path like the British and French colonies did. In fact, as Mintz has observed, a sharp counterpoint describes the evolution of the two groups of colonies (Mintz 1965). Slave systems developed in the British and French possessions soon after the initial European settlement in the early seventeenth century. Transformed speedily into plantation enclaves, which supplied their metropolises with high-demand tropical commodities like sugar, these "classic" slaveholding colonies peaked in the late 1700s, only to decline abruptly after abolition in 1834 and 1848 in the British and French areas, respectively. Spain's possessions, on the other hand, were settled more than a century earlier and experienced a brief cycle of sugar and slavery during the middle decades of the sixteenth century. But after an abrupt collapse of the export economy in the late 1500s, they did not become significant exporters of plantation staples again until the final decades of the eighteenth century (Cuba) and the early years of the nineteenth (Puerto Rico).

The Spanish experience was clearly uncharacteristic, at least by the standards of the classic sugar colonies. Social structures and institutions took shape in Spanish areas in ways quite different from those of their neighbors. Whereas in the British and French colonies, slaves, mostly attached to plantations, comprised the vast majority of the population, in the Spanish islands throughout the 1600s and 1700s enslaved peoples constituted a relatively small minority. Few of them worked on plantations, while most either lived in the urban centers or worked in large, open ranches (*hatos*); in smaller, enclosed ranches called *criaderos* and *corrales*; in farms producing foodstuffs and cash crops like tobacco (*estancias*, *conucos*, and *vegas*), or in the seafaring trades. In each of these situations, moreover, slaves labored alongside free people, many of whom themselves descended from Africans. Because racial distinctions did not have to bolster and perpetuate the primary labor system, color lines were not as sharply drawn in this type of social climate as in the slave societies of the British and the French. Indeed, widespread miscegenation had occurred in the Spanish-occupied zones throughout the early colonial centuries, and by the 1700s free rural folk of African descent comprised the bulk of the islands' population. On top of this largely peasant substratum, there was a relatively small layer of urban artisans and a comparatively weak elite of cattle ranchers, a few sugar and tobacco farmers, smugglers, merchants, clergymen, high-level bureaucrats and military officers.

The Spanish islands therefore do not conform to Williams' schema of rising labor demands in the mercantilist era followed in the nineteenth century by economic decline and forced abolition of an expendable labor system, no longer profitable for the capitalist metropolises. Still, even though slaves were almost always a minority within the rural working population until the reemergence of sugar cultivation in the late 1700s, slavery has emerged as a central theme of Spanish Caribbean historiography in recent years. Inspired by slavery studies elsewhere, economic and social historians of Cuba and Puerto Rico have focused considerable attention on formal aspects of African bondage, whether economic, social or simply institutional in the traditional sense.

This focus, fruitful as it has been, may have exacted a price. Indeed, scholars have not paid an equivalent attention to the broader spectrum of unfree or less-than-free labor systems, of which slavery was but one case, though clearly the most notorious and morally detestable. Thus the focus on slavery may have produced, however unintentionally, a somewhat narrowing or reductionist effect on our understanding of social evolution in the two Antilles. Among students of rural history, inquiry into class dynamics *outside of the formal bounds of slavery* has been consigned to a position of secondary significance behind the analysis of slavery *per se* – that is, behind the study of the slave system in isolation of other social phenomena. The tacit assumption would seem to be that a system of labor with a clear legal definition – i.e., slavery – is socially more significant than competing or alternative systems, which may be less clearly delineated in law, and perhaps therefore less readily conceptualized. In particular, this notion may have impaired our understanding of laboring groups outside of formal bondage, especially of the peasantry. Although peasants of various types comprised the principal laboring rural groups for generations before the rebirth of the plantation system, few have studied them systematically. More broadly, scholars may have overlooked, or at best oversimplified, the manner in which Spanish Caribbean societies evolved from their predominantly peasant beginnings into the segmented, class- and race-stratified formations one encounters at the height of the slave plantation period in the mid-1800s.¹

It would be a fruitful exercise, then, to examine the rebirth of plantation slavery in a more encompassing light, in which property rights in man come into view as one of several competing forms of labor exaction. The need to explore peasant adaptations as part of a continuum of rural labor forms is even more sharply drawn for Puerto Rico than for Cuba. In the smaller of these two colonies, even at the height of the sugar plantation period, slaves were never more than 14 per cent of the population, compared

to more than 40 per cent in Cuba. Still, recent studies have shown for Puerto Rico how a slave-based sugar economy developed swiftly after 1815 in response to such factors as high prices, heightened immigration of foreign capitalists and skilled workers, and Spain's enactment of more liberal trade policies, especially in regard to the slave trade and to commercial relations with the United States. Hence, scholars have had to revise prior conceptions which regarded the island as a special case among Caribbean societies in the age of slavery, in that presumably the development of its sugar sector "owe[d] but little to African labor", in Noel Deerr's informed but now disesteemed opinion (Deerr 1949-50:1, 126). Newer scholarship has shown that before the slave trade ended around 1850, Africans and Afro-creoles in bondage supplied at least 90 per cent of total labor inputs in the more modern and efficient sugar *haciendas* and between 70 and 90 percent in the remaining plantations. Altogether, slaves accounted for the bulk of labor employed in the plantation sector, and only gradually did non-slave workers come to occupy significant occupational slots in the sugar work force. These findings, I might add, have run parallel to equally fruitful discussions of class relations in the coffee areas of the interior, and of related issues like the character of the colonial state and the rise of nationalism (Scarano 1977; Scarano 1984; Ramos Mattei 1981; Curet 1979).

Although historians now have a better grasp of the evolution of Puerto Rican labor systems in the age of expanding commercial agriculture, nagging questions remain: How does one explain the shift toward greater reliance on expensive, imported labor, when a large potential mass of workers existed in an island already densely populated? Why did the elite seem to waver throughout the nineteenth century between supporting slavery, on one hand, and on the other, searching to insure an adequate labor supply through other means, such as coercing peasants into plantation work? And why, if slavery proved so crucial to the most dynamic economic sector - sugar - were abolitionist sentiments so strong throughout the nineteenth century?

Scholars have only begun to address some of these issues, especially that of the rationale for slavery amidst an abundance of potential workers. The most compelling answer, formulated initially by the pioneer sociologist and historian, Salvador Brau (1882), and endorsed more recently by scholars like Mintz (1959), Bergad (1983), Scarano (1984), and Dietz (1986), addresses the issue in somewhat structural terms. The argument essentially states that an abundance of free rural dwellers does not automatically translate into an abundant *labor supply*. This view holds that peasants

would not willingly work on plantations if they could still get access to the land. The proponents of this thesis point to the persistence of a low ratio of farming to available land throughout the nineteenth century. There were, in the apt Spanish phrase, "*mucha gente, pocos trabajadores*" (many people but few workers).

This explanation casts the issue in terms of the familiar open-resources thesis advanced by classic theorists of slavery and imperialism (Nieboer 1900; Patterson 1977; Domar 1979). Where the land-labor ratio is high, the so-called Nieboer-Domar hypothesis goes, free people will not willingly work for low wages and hence laborers must be fixed to the land forcibly. Of course, scholars have modified this proposition to take into account special conditioning factors, such as the labor process itself and the workers' attitudes toward productive practices, processing technologies, and living and working conditions in a given industry or economic activity. Such clarification of the classic hypothesis on colonial slavery is essential for Caribbean studies, as it allows one to explain how the special association between sugar and slavery in the region originated and maintained itself even as the land-labor ratios varied considerably from island to island and from one epoch to another. Thus, ratifying what students of Caribbean history have long surmised, recent work in the demography of plantation life has revealed that it was the ecological and technological arrangements of sugar production which degraded workers the most. Sugar consumed human beings; it heaped excessive labor demands on them and submitted them to extremely arduous health and subsistence conditions attendant upon such labor demands (Higman 1976; Craton 1978; Higman 1984; Dunn 1987. That these human beings were slaves, and not people with choices concerning their residence and labor (and those of their kin), is explicable in light of the perpetuation of the old-style, voracious sugar-plantation labor process in the Caribbean area at least through the nineteenth century.

For an historian of Puerto Rico, the recent emphasis on the impact of the labor process of tropical sugar-making, and on the usefulness of this distinction for understanding the adoption of slavery in cane sugar areas, is especially welcome. For in studying the revival of that island's slave system in the nineteenth century, one is struck by how slavery came to be associated so closely – alas, almost exclusively – with sugar, in the context of a diversified economy and society that featured other export-agricultural activities (e.g., coffee and tobacco) and a large peasant sphere. Indeed, few cases illustrate the economic allure of the rights exercised by masters over their slaves better than Puerto Rico in the period 1815 to 1850. Likewise, in few other instances can it be demonstrated so clearly

how juridically free persons resisted being forced into the demeaning and quite simply dangerous conditions that prevailed on sugar plantations.

In this island during the sugar boom of the first half of the nineteenth century, beginning sugar planters faced a peculiar dilemma: either they adopted slavery, whose lifeline from Africa faced a serious legal challenge after the enactment of the 1817 Anglo-Spanish treaty to abolish the Spanish colonial slave trade, or they elaborated some way – presumably involving remuneration, coercion, or both – of organizing the labor of the abundant free population. In the short run, most planters chose the risks of contraband slave trading over the economic disadvantages of peasant labor. Peasants, the planters figured, were undependable and restless, and therefore unfit for the intensive labor imposed by time-proven cultivation methods and by the standard sugarmaking techniques and machinery. Since peasants viewed salaried labor as an adjunct or complement to independent cultivation, performed on their own or someone else's land, they naturally tended to work only for as much time as was necessary to reach their expected level of monetary income. Absenteeism, much loathed by planters and managers for its disruptive impact, consequently ran rampant among peasant laborers on Puerto Rican plantations. This was especially true of peasants who were employed in sugar production during the apogee of slavery, in the second quarter of the nineteenth century.

Yet, while the Nieboer-Domar hypothesis, as complemented by the more recent discussion on the labor process in sugar, no doubt has considerable explanatory power, it presents certain difficulties to the historian. One of its shortcomings has been pointed out by Walter Rodney, O. Nigel Bolland and others, who have cautioned against using the land-labor formula too mechanically in trying to explain the rise of the peasantry in the British West Indies after Emancipation. These scholars rightly claim that the availability of land may be in itself a function of class relations and state-imposed restrictions (Rodney 1981; Bolland 1981; Scarano 1989). Moreover, for the late-developing plantation colonies of the Caribbean and, more specifically, for Puerto Rico, the thesis presents yet another difficulty. Not regarding the making of labor systems as a dynamic and imaginative social process, proponents of the structural explanation have yet to show in the Puerto Rican case how the shift toward slave-produced sugar after 1815 dovetailed with prior attempts by landholding groups to fashion a suitable work force from various constituents, particularly from the peripatetic native peasantry. There is, in short, too much emphasis on the structural factors and not enough on the historical ones.

In Puerto Rico there were attempts at labor control which mirrored the growth of export agriculture before the onset of the sugar boom proper.

The elites' project for new social relations in the countryside combined, moreover, with Bourbon reforms that in the waning years of the eighteenth century attempted to strengthen the colonial bond and thus ensure the stability of a colony regarded by military strategists as a key player in imperial defense. Invariably, the social agenda of landowners and bureaucrats became entangled with demographic and agrarian changes whose direction, velocity, and consequences few people could foresee and much less control.

I would argue that the discussion on Puerto Rican rural relations in general, and on slavery in particular, should not lose sight of these early efforts at experimentation with, and control of, peasant labor. I would further suggest that by looking at these initial steps in the direction of more effective labor control one begins to appreciate the complexity of the slavery issue in nineteenth-century Puerto Rico. In this light, the island's claim to peculiarity or uniqueness among slave societies would not seem to lie in its scant use of slave labor in the export sector, as some analysts have claimed, but in the delicate coexistence of mainly incompatible approaches to the problem of rural social relations – that is, in the rivalry between two visions or discourses, each one corresponding to a different model of labor exaction. I would suggest, finally, that this dichotomy originated in the later 1700s, a period widely regarded by historians as a prologue to the plantation-style developments of the post-1815 period. In looking at how social processes and imperial policies shaped these competing visions of rural life, the discussion that follows is perforce preliminary, since much of the requisite groundwork on the economic and social history of the period is still wanting.

In Puerto Rico the agrarian situation unraveled in fascinating ways during the second half of the eighteenth century. As in other so-called peripheral areas of the Spanish empire, the economic and demographic foundations of insular society underwent rapid changes during the climax of Bourbon reformism in the age of Charles III (Morales Carrión 1952). These changes, to be sketched below, entailed a reexamination of both landholding practices and social relations in the countryside. More significantly for our purposes, they gave rise to parallel but competing visions concerning the manner in which labor should be appropriated and organized in the export-oriented economic sector. It was in the second half of the eighteenth century that these two visions – the pro-slavery discourse, chiefly associated with the more powerful elements of the sugar bourgeoisie, and the discourse on peasant coercion, articulated by more traditional elements of the landholding groups – became fixtures of Puerto Rican elite ideology. In what follows, I will briefly look at how these visions emerged from the structural changes of the Bourbon period.

Until about 1750, Puerto Rico deserved its reputation as a backwater of the Spanish empire (Picó 1986; Sued Badillo and López Cantos 1986). Its scarce population of 20 to 40,000 at the time – already much larger than it had been in the seventeenth century – endured largely subsistence conditions. Scattered about the densely forested coastal plains and interior highlands, they dedicated themselves primarily to cattle raising, forestry, and yeoman farming. Commercial exchanges with Spain and its colonies were infrequent and largely undependable; it was more common for the islanders to trade with smugglers along the unprotected coasts than to observe the rules of Spanish imperial exclusivism.

While the vast majority of the people lived dispersed throughout the rural landscape, urban life was a privilege of the very few. Though colonists had organized several small villages in the late 1600s, only San Juan and San Germán existed as organized towns with city governments. This territorial division had not changed at all since the Crown had chartered the first municipalities at the time of the Conquest. The largest of the two towns was, of course, the walled and fortified capital city, one of Spain's primary defensive outposts in the Caribbean region. The colony's chief administrative and commercial, as well as military, center, San Juan was home to a motley assortment of bureaucrats and soldiers from various parts of the Spanish dominions, a growing number of whom elected to settle in the island at the conclusion of their service. The city also harbored a relatively small group of creole and peninsular landowners and merchants, a Puerto Rican version of the Spanish American colonial oligarchy. The landed group devoted itself chiefly to cattle ranching, although a few owned sugar-making haciendas that produced molasses and rum for internal consumption.

On the eve of the Bourbons' effort to place the colonial system on more rational, profitable, and secure grounds, one of the striking features of this semi-isolated colony was the highly idiosyncratic Puerto Rican rural folk which no doubt owed some of their peculiar features to the character of original settlement. Many of these rural inhabitants descended from persecuted or victimized people, occupants of the underbelly of the Spanish empire: fugitive *encomienda* and enslaved Indians, some of them native Arawak but most probably Caribs brought over as slaves from neighbouring islands after the aboriginal population had been depleted soon after the Conquest; African and Afro-creole maroons; Spanish soldiers who deserted from the feared and detested San Juan *presidio*, whose reputation was so hellish that in the early years of the seventeenth century, a military commander en route to the Spanish Main with a battalion of fresh troops exclaimed that he could not in good conscience force any of them to stay

in San Juan, for it would be like condemning them to "eternal slavery" (López Cantos 1975:221); and, finally, other Spanish deserters, mainly from the imperial fleets that used to stop over on the island's western shore to take on water and provisions. Repeated attempts to capture and punish these fugitives had failed. By the middle of the eighteenth century, colonial officials tacitly understood that no matter how illegitimate these people's claim to citizenship may have been at first, they were now a demographic asset. In an underpopulated strategic possession threatened continually by a tightening circle of adversaries, Spanish authorities obviously preferred settlement of any kind to no settlement at all.

Partly because of its peripatetic origins, and partly on account of certain features of the agrarian regimen that I will discuss shortly, a significant proportion of the Puerto Rican peasantry had evolved into a restless lot – indeed, a roving, itinerant mass of people. Members of this group, collectively known as *desacomodados* (literally, "those who lack accommodations") roamed about the territory searching for land to squat on. Few stayed in one location for any length of time. They could not obtain land through legal means, as the usual practice was to grant usufruct licenses to powerful or well connected settlers; only rarely did the poorest folks receive the pertinent *mercedes*. Thus, paradoxically, there emerged in this fertile and sparsely cultivated island a sizable group of rural dwellers who were unable to secure permanent access to the land. Of course, some landowners made the best of the situation, allowing the landless to live on their holdings in exchange for occasional services. Cultivators living on someone else's land in this manner were known as *agregados* (loosely, "hangers-on").

As island population growth accelerated in the second half of the eighteenth century, the landless group multiplied. Between 1765 and 1800, the total population grew from 45,000 to 155,000, an advance which averaged a very high 3.55 percent per annum for the period.² The growth rate was highest for blacks and mulattoes, in both the free and the slave categories; hence, the population explosion affected the most those groups which would continue to nourish the ranks of the dispossessed peasantry. Because of the peasantry's troublesome penchant for itinerancy and independence, its demographic increase in the late eighteenth century carried with it profound, if also contradictory, implications. For one, the population explosion raised the elites' and imperial officials' interest in the racially mixed, destitute peasantry as a potential source of labor, at a time of increasing opportunities for commercial farming. Second, the group's mobility challenged the elites' capability for social control. *Desacomodados* lived on the fringes of society. For the State, this meant that they were

outside the reach of militia conscription – a mounting concern after Spain's defeat in the Seven Years' War. At the same time, the peasantry's demographic upsurge worried Church leaders, who probably realized that rural folk would continue to live being influenced only minimally by the pitifully small secular clergy. These preoccupations converged in the second half of the eighteenth century around a larger socioeconomic problem: the antiquated nature of agrarian structures. To Spanish authorities, new modes of appropriating and using land seemed an appropriate response to the challenges posed jointly by the expansive landless peasantry, the opening up of commercial opportunities, and the international rivalries of the age.

Thus, in order to assess Puerto Rican efforts at recasting the rural population into a reliable work force and a dependable citizenry, one must examine the agrarian problem and its solutions as contemporaries conceived them. In the latter 1700s the agrarian issue essentially comprised three interrelated sets of problems: 1) land was too concentrated and underexploited; 2) population growth under existing rules of tenure and use strained the population's capacity to sustain itself; and 3) the preeminence of extensive animal husbandry strangled the more alluring forms of agricultural development (i.e., export agriculture). Antiquated structures prevented the resolution of these interconnected problems. Beginning in the first half of the sixteenth century, much of the island's productive land had been partitioned into *hatos* where herds of cattle roamed freely and into *criaderos* and *corrales* for raising *ganado menor* (pigs, goats, sheep, and other small animals) (Wales 1973; Gil-Bermejo 1970; Coll y Toste 1914). In 1775, the San Juan municipal council reported the existence of nearly 300 such *hatos*, a number that had not changed much in two centuries. Collective possession of *hato* lands was the norm. Most units had several shareholders, each of whom was entitled to raise a maximum number of animals, according to the value of his or her share. As was the case with all Puerto Rican landholding, *hato* titles did not confer property rights, which the Crown reserved for itself. For a fee, the cabildos of San Juan and San Germán allotted and legalized landholding through the concession of usufruct titles. This practice allowed cabildo functionaries, who for the most part were members of old elite families, to reward relatives, acquaintances and business partners with significant land concessions. By the early 1700s newly settled military officers and high clergyman received a large share of new land *mercedes* as well.

This agrarian scenario, in which *hatos* were predominant and property rights on land were not yet established, began to show signs of strain

as the first half of the 1700s progressed. By the latter part of the century, traditional land tenure and land use practices presented a spiny dilemma. Unable to adapt to new conditions, the *hato* system began to disintegrate. The challenge to traditional institutions came from several fronts. With the island population growing at a faster rate than ever before, there was a pressing need to expand the agricultural frontier in order to accommodate an increasing number of subsistence cultivators. Furthermore, new export opportunities arose with the development of trade with Spain and the sister colonies, as well as with Saint Domingue, other French, Dutch, and Danish colonies, and English-speaking North America. These opportunities related primarily to coffee, which showed alluring commercial possibilities soon after its introduction in the 1730s. The coffee bush adapted peculiarly well to the topographical and ecological conditions of Puerto Rico. Further, its cultivation suited the colonists' limited financial resources, given the low initial outlay required for its commercial cultivation. Under the weight of such pressures, both imperial functionaries and many colonists – including not a few enterprising *hateros* who wished to position themselves for a piece of the action in commercial agriculture – began to clamor for changes in the *hato* system, increasingly regarding the archaic tenure situation as an obstacle to agricultural growth. It became clear to them that neither the concept of open grazing, with its requirement that cultivators fence off their fields if they were to coexist with the herds, nor the practice of collective usufruct could accommodate farming particularly well. If the arable area were to expand, revenues increase, and the social situation stabilized, authorities would have to promote the break-up of *hatos* and the apportionment of their lands among individual farmers.

After 1750 a consensus gradually developed among landholders and policy-makers on the merits of dissolving *hatos* in prime lowland terrain and displacing the herds to less desirable highland areas. But such a project raised thorny procedural, philosophical and legal issues. At stake were questions of fair distribution of Crown assets, the size and quality of the labor supply, the potentially beneficial effects of agrarian development on colonial revenues, issues related to the military preparedness of the civil population, and Crown notions of social equilibrium and equitable distribution of the colony's resources. Having failed to apply in Puerto Rico its policy of *composición de tierras* or sale of titles over formerly occupied lands, the Crown decided in 1758 to grant its insular vasals the rights of property over their lands, though another 20 years would pass before such a grant actually became law. After 1778, property titles would be exchanged for a modest land tax to support the arming and clothing of the local militia.

The social dimension of these land tenure reforms comprise a fascinating, unexplored chapter in Puerto Rican history. Clearly, one of the Crown's main reasons for pushing land reform was a concern for the fate of *desacomodados* and *agregados*, whose eruptive population increase few could ignore by the middle decades of the eighteenth century. Officials on both sides of the Atlantic recognized this group's socially destabilizing potential. In 1751, for instance, members of the San Juan town council determined that it was in the public interest to break up two *hatos* in the highland sections of Manatí, a district several leagues west of San Juan, in order to redistribute some of their lands among the "many poor *desacomodados*" of the locale. And in a passing reference to social unrest, the cabildo mentioned that the need to reestablish peace and quiet among the district's inhabitants justified its decision, which injured the claims of the *hatos*' legitimate occupants (Municipio de San Juan 1954:4-5).

The Manatí affair prompted the earliest recorded declarations of concern over the unsettling potential of the *desacomodado* question. From that point on, governmental correspondence contained frequent allusions to the landless peasantry, usually phrased alarmingly in terms of the necessity for *medidas de policía* (literally "regulating measures") to forestall more serious trouble. Such pronouncements suggest that the government became increasingly nervous about the preservation of internal order and social equilibrium, though officials sometimes couched this concern in physiocratic language, which called for government action in nurturing the development and prosperity of a numerous class of small farmers.

At the time of the Manatí incident (1751), however, most *hateros* were not yet convinced of the wisdom of government efforts to distribute surplus – and understandably marginal – lands among *desacomodados* and *agregados*. Thus, when in 1758 the Crown attempted to confer on the colonists property rights on lands they occupied in usufruct, governor Antonio Guazo Calderón decided to keep secret the contents of the Royal Cédula until a commission which he had appointed to dispense "steeply graded and uncultivated lands" (*terrenos montuosos, é incultos...*) among landless families had finished its work. The Governor justified the action to his superiors in Madrid by playing on the theme of the *hateros*' greed, "for each one [of them]," Guazo wrote, "possessed by selfishness would like to own the entire island..."³ On account of the Governor's bold decision, the far-reaching royal grant was not published or enforced on this occasion.

As late as 1758, then, *hateros* resisted the idea of accommodating the landless in uncultivated and admittedly marginal lands on their estates. But this initial opposition to the government's redistributive policy gradually

diminished over the next twenty or thirty years, as the potential benefits of the formula became clear to the landholders. After 1765, as I have said, Puerto Rican agriculture entered a period of rapid expansion due to the easing of restrictions on trade with peninsular and other colonial ports, the spending of several million pesos on military construction in San Juan, a liberalization of the slave trade, and an intensification of commercial relations with the surrounding plantation colonies, particularly Saint Domingue. With coffee, tobacco and other cash crops becoming increasingly popular among farmers, the cry for land tenure reforms – the break-up of *hatos* and the obtainment of property titles – gathered momentum. By the mid-1770s many of the larger *hato* owners had come around to the idea that reform would be in their best interests. The proposed reforms would simultaneously allow them to extend the agricultural frontier and to obtain full property rights, and therefore better control, over their lands. The possibility of capitalizing on surplus acreage also piqued their interest. Since many *hateros* had gone into farming or were poised to do so by the 1770s and 1780s, the reform agenda appeared more desirable than before. The need for capital and labor now overcame the prior resistance.

But *hateros* began to see reforms as a blessing in disguise for another reason. When implemented properly, the proposed measures could permanently settle itinerant *desacomodados* in concentrated farming villages. *Hateros* were probably aware that such concentrated communities of cultivators would augment the labor supply, particularly if towns and villages evolved from them, as expected. True, questions on how to discipline a nonslave labor force for a harsh, plantation-style regimen remained unanswered. But any quantitative increase in available laborers had to be welcome, as demands for labor power had multiplied faster than landholders with modest financial means could fill with expensive, imported African slaves.

Furthermore, the *hateros'* acceptance of reform coincided with Crown efforts to promote concentrated, village living. When Marshall Alejandro O'Reilly visited the island in 1765, he had been shocked to see how acutely rural and dispersed the colonists were. He had discovered in dismay that most people lived beyond the reach of civil, military or ecclesiastical authority. This intolerable state of affairs threatened the security of one of Spain's valued strategic possessions and might even compromise the integrity of the Empire as a whole. O'Reilly proposed to reconcentrate the Puerto Rican population into a prudent number of towns and villages (O'Reilly 1970). The Crown, for whom O'Reilly became unofficial advisor on things Puerto Rican, enthusiastically embraced the idea. Thus, when

Charles III signed the second and definitive decree granting property rights on land in 1778, he authorized the creation of three new *villas* or municipalities and expressly instructed his officials to work toward chartering more parishes and towns. Some functionaries had already been working toward that goal; for example, governor Miguel de Muesas, who counted among his proudest achievements the founding of seven new towns during the six years of his tenure (Ortiz 1983). According to one observer, *desacomodados* constituted the settler majority in one of these new towns, Cayey de Muesas (named after the sitting governor); at the time of his writing (1775), these settlers "[gave] abundant evidence of industriousness (Miyares González 1957:89-90)." Other sources point to an analogous connection between town foundings and reconcentrations of landless peasants in other parts of the island.

As the *hato* system gradually disintegrated and farming began to dominate the Puerto Rican rural scene, then, the Crown and its once reluctant collaborators, the *hateros*, could point to some meaningful achievements in the area of labor control. Their cooperation had begun to turn the corner on peasant itinerancy and undependability. Turning that corner may have been a significant step for employers of labor who did not require constancy in work attendance and machine-like discipline in the performance of productive tasks. On the other hand, it may not have been good enough for the sugar plantations, an economic sector that, as we have said, due to its technical complexity, demanded uninterrupted inputs of labor and a stricter worker discipline. After 1815, when sugar cane began to emerge as the dominant crop in the lowlands, planters in Guayama, Ponce, and elsewhere employed peasant laborers to clear the original brush and plant the first crops (Scarano 1984). But the same planters quickly turned to the slave trade for a solution to their permanent labor demands, evidently because peasants were only willing to work for low wages and under extreme duress for short periods, when they needed cash. Once that need was satisfied, peasants preferred the relative autonomy of their own plots, where family labor filled essentially minimal consumption demands.

One must be careful, therefore, not to read too much success into the labor-control experiments of the late 1700s. For one, the thrust for agrarian change diminished in the waning years of the eighteenth century, so that the definitive break-up of the *hato* system had to await the early decades of the 1800s (in the lowlands) and even the middle years of that century (in the interior highlands). Second and more importantly, a significant portion of the Puerto Rican peasantry continued in its irrepressible old ways well after the Crown's concern for the problem of rural indiscipline

in its Caribbean colony had abated. This was the impression, at least, of leading landowner spokesmen. When in 1809 Don Pedro Irizarri, on behalf of the San Juan *cabildo*, presented a species of *cahier des doléances* to Ramón Power, island representative to the Seville Junta, the question of agricultural labor occupied a lengthy part of his discussion (Ramírez de Arellano 1936). Irizarri condemned the *agregado* system as injurious to the welfare of the colony. But he fell short of endorsing slavery, a system which, in his opinion, carried the seed of its own destruction, as the experience of nearby Haiti tragically showed. Significantly, in expressing disapproval of the African slave trade, Irizarri alluded to the short-sightedness of the *bando negro* or "black camp", a clear reference to opposing visions of how rural labor should be organized. In this patrician's view, the solution to the problem of agricultural work was not slavery but immigration from the Canary Islands and New Spain, as well as the eradication of the *agregados*. To Irizarri and other contemporaries, the creole peasant adaptation seemed, now more than ever, a proper target of rural reform. Though it is doubtful that Irizarri had anything to do with it, only a few years later the government renewed its harassment of the landless peasantry. This time it launched a protracted campaign against the "parasitic" *agregados* which culminated in the compulsory labor law of 1849, the infamous *Reglamento de Jornaleros* (Dietz 1986:42-53; Gómez Acevedo 1970; Mintz 1951).

Thus the late eighteenth-century dynamic between *hateros* and bureaucrats, on one side, and *desacomodados* and *agregados* on the other, may well have originated and set the tone for a peculiarly Puerto Rican discourse of coercion and control (Duany 1985; González 1980). At a later date, that discourse would become a fixture of Puerto Rican upper-class ideology, a prime conceptual ingredient in the protracted insular debate over slavery and free labor.

NOTES

1. Although a colony of Spain until 1795, and again from 1809 to 1821, Santo Domingo was a special case due to the spill-over effects of the Haitian Revolution. Therefore, much of the discussion that follows focuses on Cuba and Puerto Rico.

2. The data on population are from a 1765 census compiled by *visitador* O'Reilly (O'Reilly 1970), and from annual summaries remitted to Spain by insular authorities in the final quarter of the century. Some of these annual censuses have been published (Gil-Bermejo 1970: 32-33, Abbad y Lasierra 1970:153; Brau 1906:199). A nearly complete set for the period 1779-1802 exists in the Archivo General de Indias in Seville.

3. Antonia Guazo Calderón to D. Julián de Arriaga, March 24, 1759, Archivo General de Indias (Sevilla, Spain), Indiferente General 1661.

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THE AMELIORATION OF BRITISH WEST INDIAN SLAVERY,
1750-1834: TECHNICAL CHANGE AND THE PLOUGH

INTRODUCTION

Over the last forty years the study of British West Indian sugar estates during the period of slavery has shown that they achieved significant technical change. This work qualifies older views, best expressed by L.J. Ragatz, according to which planters, constrained by absentee ownership and the inefficiencies of slave labour, proved almost incapable of combatting the sugar monoculture's tendency towards soil exhaustion, or of responding effectively to the many external pressures which began to work against them in the later eighteenth century (Ragatz 1928). Thus, the argument ran, when slavery came to an end in 1834, most British West Indian plantations had been reduced to virtual bankruptcy, except perhaps in a few of the most recently settled territories where the cane land was still exceptionally fertile.

It now seems that this very pessimistic interpretation was coloured rather too much by the public controversies of the early nineteenth century, originally the main source of information available to historians. In contemporary debate on West Indian issues the two main contending parties both gave a bleak impression of the sugar estates' fortunes. Proprietors emphasised their commercial distress, and the need for commercial privilege; their critics, arguing for slave emancipation, were pleased to accept evidence that slavery was inefficient and unprofitable as well as inhumane. Since Ragatz, attention has shifted more to the privately-kept records of sugar estates, as they have become available for research (Bennett 1958; Craton & Walvin 1970; Pares 1950; Sheridan 1974). The general drift of this work has been to detect a measure of technical adaptation during the period of slavery, achieved through modified processing equipment, new cane

varieties, and greater attention to manuring, livestock, and fodder supplies. So for British West Indian sugar estates, at least, the "classic" indictment of slave labour as associated with only the most rudimentary techniques and with a tradition-bound master class, can no longer be sustained.

But how far should the revisionist line of argument be pressed? Considerable differences of emphasis and scope for debate remain within the literature. Thus Pares's investigation of the Pinney family's Nevis property, the first British West Indian history to make thorough use of estate papers, showed some planters with a concern for improvement and the details of management. Yet, he argued, absenteeism and competition from more recently developed colonies had ruined Nevis before the slaves were freed (Pares 1950: chs. 6, 7, 12). On the other hand, the Barbados estates of the Society for the Propagation of the Gospel, studied by Bennett, enjoyed a striking economic regeneration in the early nineteenth century, even under absentee ownership, with rising profitability and sugar consignments. Also a marked improvement in the slaves' material condition came through "amelioration" policies, aimed at establishing a self-reproducing labour force. These policies had been encouraged since the 1760s by growing difficulties in acquiring new slaves from Africa, and by the growth of the metropolitan antislavery movement (Bennett 1958: chs. 9-12). Craton and Walvin have identified major innovations undertaken between the 1790s and the 1820s at the Worthy Park estate in Jamaica. They imply, however, that the degree of economic resilience enjoyed by this property was exceptional, perhaps helped by the supplementary financial resources to which its owner had access (Craton & Walvin 1970:168-82, 187-8). Also, Craton's analysis of Worthy Park's slave population suggests that increased productivity was achieved at the cost of severe social and demographic stress (Craton 1978: Part I). Watt's recent study shows that British West Indian planters made some adjustments, mainly in response to environmental changes, but concludes that their general agricultural performance was mediocre, judged by the standards of the mother country (Watts 1987: ch. 9).

From my own work, based mainly on estate papers accumulated by absentee proprietors in Great Britain from the "old" British West Indian colonies (Barbados, the Leeward Islands, and Jamaica), I believe that the slave-based plantation economy showed a substantial capacity for innovation (Ward 1988). The basic pattern of amelioration described by Bennett for the Codrington plantations appears, if only in an attenuated form, on many other properties. Improved maintenance standards and reduced work loads brought a marked fall in slave mortality, so that colonies which

had depended on regular deliveries from Africa to maintain their populations until late in the eighteenth century had achieved, or were approaching, demographic self-sufficiency by the 1820s. I would go further in emphasising the business advantages from this shift in policy. Bennett saw the balance sheet effects of amelioration as essentially neutral: the planter's extra spending on food, clothing, and medical care for his slaves was more or less offset by their reduced depreciation (Bennett 1958: 138-40). It can however be argued that greater benefits accrued to the estate than this comparison implies. Nineteenth-century slaves were not only better able to reproduce themselves than their eighteenth-century predecessors, but also, from the employer's point of view, more useful: likely to be creole rather than African (and thus more experienced in estate work), more tractable, and less likely to be incapacitated by malnutrition or punishment. These effects may be discerned in, for example, the reduced incidence of theft, the reduced employment of white supervisors (one of the largest plantation expenses), and the increasing average stature of Jamaican-born slaves (which presumably brought some corresponding addition to their physical strength). Taking Jamaica as the standard, I estimate the aggregate economic results of amelioration and its associated agricultural reforms on sugar estates in the 'old' British West Indies as an increase in output per slave of about 35 per cent between 1750 and 1834, or about 0.4 per cent per year, a respectable performance by contemporary standards (Ward 1988: 190-208, 261-2).

Nevertheless, while sugar planting in the 'old' British West Indies clearly made important advances between 1750 and 1834, it might be argued that to show this is to deal with only part of the original critique against slavery as an economic system, that the masters of slaves were by nature negligent and benighted. Another allegation, that the slaves themselves were inferior to free people in their quality as workers might still have weight, if it can be shown that West Indian progress was restricted to innovations which did not require extra skill or commitment from the labour force. For example, during our period, as a result of the British Industrial Revolution, planters had the benefit of improved grinding mills. The task of the slaves who fed in cane between the rollers remained essentially unchanged, but because the mills were braced more tightly, a reasonable proportion of juice could be extracted in just one or two passes, instead of the five or six passes required with older devices. Thus the amount of juice delivered per worker and per hour greatly increased. Similarly, new cane varieties arrived on the islands, and many planters adopted them, together with the increased cultivation of fodder crops, to establish in some cases a 'virtuous circle' of improved livestock, extra manure, enhanced

soil fertility, and better harvests, of the kind which had already transformed grain farming in Great Britain (Ward 1988: ch. 4).¹ Once again, technical change need make little difference to particular tasks – weeding, cane cutting, etc. The productivity of the field gangs could be enhanced simply by changing the proportions into which their work was divided between the cultivation of sugar cane and complementary activities. To this extent labour's role was merely passive. Black slaves – either in fact, or in the perception of their masters – may have been clumsy, obstructive, and difficult to educate in new skills. However, such characteristics need not, and clearly did not, prevent certain innovations (Boomgaard & Oostindie 1989: 10-2).

But what if there was also at least a potential for raising efficiency by making tasks more sophisticated, perhaps through using new items of equipment – such as steam engines – which might be vulnerable to sabotage, and require higher levels of skill from the workers responsible for their operation and maintenance? It is the compatibility of slavery with the steam engine and the vacuum pan that has provided the focus for debate about the relationship between technical change and labour regimes elsewhere in the nineteenth-century Caribbean (Scott 1984). Yet this is not a very useful theme for the pre-emancipation British West Indies. In fact the components of 'modern' sugar processing made very little headway in the British sugar colonies before 1834, but the technologies of steam power and vacuum boiling were as yet so imperfectly developed that their limited diffusion cannot be plausibly attributed to slavery.

Therefore the rest of my paper will concentrate on the plough as a substitute for the hoe in cultivation. I am conscious that this is a narrow and now rather venerable issue, but it seems nevertheless to be worth pursuing. Ploughing entailed new skills for field workers. Also, even though it was a mature technology, perhaps offering significant cost saving over traditional hand methods, many contemporary observers and later historians have alleged that planters were slow to introduce it, at least partly because of the constraints from slave labour. I argue that the extent to which the plough was used in British West Indian sugar estates before emancipation has probably been underestimated, at least for Jamaica (which had half the British Caribbean slave population). Physical geography was much more important than the institution of slavery as an obstacle to ploughing. However, the economics of technical change in plantation agriculture cannot be definitely established, for we must contend with difficult problems of evidence. While it is clear that slavery was *compatible* with substantial technical advances in the British West Indies between 1750 and 1834, the extent to which the human degradations associated

with this labour system stopped progress from being even greater remains uncertain.

THE PLOUGH IN THE 'OLD' BRITISH WEST INDIES

Ploughing made more progress on Antigua than anywhere else in the British West Indies. The first experiments, undertaken on this island in the mid-eighteenth century, seem to have been abandoned by the 1780s (Ward 1988: 73). After 1800 the practice revived. At the Parham estate, the colony's second largest, the plough was applied in the 1820s to some 70 per cent of the cultivated area,² and it had also become widely used on neighbouring properties (Porter 1831: 293-7; Ragatz 1928: 66). However, on the other Leeward Islands and on Barbados all the signs are that ploughing remained rare during the period of slavery (Davy 1854: 113-14; Bennett 1958: 103). More abundant information survives from Jamaica. Almost every one of the dozen or so estates in the colony for which records have been studied experimented with the plough between the 1760s and the 1780s. Then the practice fell temporarily into disrepute, but with labour in short supply after the closure of the slave trade in 1808, most planters had resumed ploughing by the early 1830s (Ward 1988: 82-3).³

What was the subsequent course of innovation? Some historians suggest that emancipation greatly intensified planters' concern for field mechanisation, implying also that it had been held back by slavery (Hall 1959: 48; Green 1976: 205-6; Boomgaard & Oostindie 1989: 7-8). Yet while the plough may have come into wider use after 1834, the available evidence does not make clear to what extent, if at all, its rate of diffusion accelerated. Accounts from Antigua during the first years of freedom were rather equivocal about trends in current practice. According to one report, 'great improvements [including ploughing] have long ago been demonstrated to be necessary and practicable'. 'The plough has long been used in the island...' Nevertheless, '...on many estates its judicious use is still a novelty', and 'ploughing was gaining ground, as a consequence of the reduction in labour supply since the ending of slavery'. (Sturge & Harvey 1968: 51, 57, 73). Among eight respondents to an official inquiry, only three stated that the plough had become more common, and two of these did so in guarded terms: 'I have understood, and on one occasion I saw, more ploughs at work than were formerly used.' 'The increased use of the plough has in some small degree supplied the place of human labour....' Three others were categorical that ploughing had not been extended (*British Parliamentary Papers* 1836: 274).

There are similar difficulties with the evidence from Jamaica. The visiting philanthropists Sturge and Harvey identified ploughing as an apparent novelty – at least the work was often being managed by white immigrants (Sturge and Harvey 1968: 173, 216, 230). Craton argues that the practice did not become at all common at Worthy Park before the 1830s (Craton 1978: 226). But some planters, testifying to the public inquiries of the 1840s, denied that free labour had brought any decisive change to the rate of innovation. According to a witness from St. Thomas-in-the-Vale parish, 'the use of the plough was extending itself very much during the period of slavery, and it is now almost entirely used for opening the land'. The plough had 'not very much increased since the end of slavery -we had carried it to a great extent before.' A St. Thomas-in-the-East planter, while reporting that the plough 'is now extending very much', said that he himself had used it for thirty years. On the Delve estate, Westmoreland, the plough had been used since 1816 (*British Parliamentary Papers* 1842: QQ 4788, 5050, 5053; *British Parliamentary Papers* 1847-8: 167). These were of course *ex parte* statements, by men anxious to show that although real attempts had been made at improvement, the sugar estates still required metropolitan support through immigration schemes and protective duties. But Sturge and Harvey, enthusiasts for free labour, also had a case to argue, and the planters' assertions about the progress of ploughing before emancipation are at least partly confirmed by estate records.

Establishing the extent to which planters adopted the plough is hard enough. When we come to consider *why* it was or was not used, and, more particularly, how the choice of technique was affected by the institution of slavery, our difficulties are aggravated. As is well known, contemporary remarks on the subject noticed various problems, including the intractability of the work force, but also physical constraints – stiff soils, hilly terrain, the need to maintain drainage ditches and minimise soil erosion, and the obstacles to maintaining livestock in the West Indian climate. The importance of physical influences is suggested by the obvious differences in practice among slave colonies, for example between Antigua, with its fairly level cane pieces, where ploughing had become quite common by 1834 (even if it is not clear exactly how common), and the more mountainous territories – such as Nevis, Montserrat, or the Windward Islands – where the plough remained almost unknown (*British Parliamentary Papers* 1842: Q 2729; Green 1973: 449-51; Watts 1987: 430-1; Ward 1988: 60-83). But what was the relative importance of geography and the labour regime in determining whether or not the plough was used? To what extent might physical problems have been coped with more successfully if the estates had been provided with a work force free of the demoralisation

and inflexibilities of slavery? It has been suggested, for example, that masters' low expectations of their labourers, whether derived from racial prejudice or daily experience of slave sabotage and recalcitrance, had established the conviction that the element of skill in plantation routine should be kept to an absolute minimum. Some of the evidence that has been offered on this point may not be entirely authentic. Thus the report that slaves were not trained as ploughmen because their masters considered them to be incapable of seeing straight enough, came from a stipendiary magistrate, recently arrived on Jamaica in 1835, with no first-hand knowledge of slavery (Bell & Morrell 1928: 397). Nevertheless, statements were made by experienced planters which emphasise a labour problem, in terms that perhaps imply assumptions of racial incapacity, and not just the usual difficulties to be expected when workers were learning a new task. In the 1770s a Jamaican mentioned, among other obstacles to ploughing, 'the want of care and dexterity in the negroes', although he still intended to persevere with it.⁴ Half a century later Thomas Roughley, also of Jamaica, wrote in similar terms about the plough's unsuitability: '...the people in that country ignorant, cattle and negroes hard to be trained for it....' (Roughley 1823: 269-72).

However, observations of this kind do not always seem credible or representative. It was an Antiguan who declared in 1788 that 'nothing has yet been found so completely suited to the Disposition of the Slaves' as the hand hoe (*British Parliamentary Papers* 1789: Part III, Antigua, No. 42). Nevertheless, the plough would spread more rapidly in this colony than anywhere else in the British West Indies. Mathew Lewis's account of experiments on his Jamaican estate in 1816-17 is celebrated: '...the awkwardness, and still more the obstinacy, of the few negroes, whose services were indispensable, was not to be overcome; they broke plough after plough, and ruined beast after beast, till the attempt was abandoned in despair.' Yet his qualifying sentence should not be overlooked: 'However it [the attempt at ploughing] was made without the most essential ingredient for success, the superintendence of an English ploughman; and such of the ploughs as were of cast-iron could not be repaired when once broken, and therefore ought not to have been adopted; but I am told that in several other parts of the island the plough has been introduced, and completely successful.' (Lewis 1929: 272).⁵ Some planters asserted roundly that slaves were capable. According to another witness at the 1788 inquiry, on Jamaica 'the Negroes learn the Use of the Plough very readily.' (*British Parliamentary Papers* 1789: Part III, Jamaica, No. 9).

But most frequently the slaves' characteristics as workers are ignored. Sometimes it is implied more or less clearly that physical considerations

were decisive. 'Although I advise you to give up ploughing, I allow it may be proper upon some estates, but not upon yours.'⁶ The plough had been given up by 1795 at New Found River, Jamaica 'because of the injury done to the stock from the hilliness of the land and the little advantage gained in saving of labour.'⁷ The failure of ploughing at Blue Mountain, Jamaica, was blamed on the need to maintain drainage trenches, obstruction from the cane trash which lay about the fields, and the over-exposure of the soil to the sun. '...I can assure you that it is not for want of inclination in many eminent planters in the Island that the Plough has not been universally adopted wherever the land would admit of it.... The pleasing idea of easing the severe and fatiguing manual labour of the negroes by the use of cattle has induced numbers to try the plough & even to persevere in the use of it for years.'⁸ According to William Taylor, one of the very few humanitarian critics of Jamaican slavery with personal experience as an estate manager, although he had made considerable use of the plough, it was impracticable in some mountain situations. He did not, however, believe that ploughing had damaging effects on the soil: '...I think they would use the plough wherever they could. I have heard overseers generally express a great desire for it.' (*British Parliamentary Papers* 1831-2, QQ 430-2). Sometimes no grounds at all are given for the policy pursued. At Mesopotamia and Island, Jamaica, the disappearance of the occupation 'ploughman' from the slave listings during the later 1790s is left unexplained.⁹

The evaluation of decisions concerning the choice between alternative techniques is a common enough historical problem. In such cases the procedure often followed is to attempt a reconstruction of the economic costs and benefits entailed, thus showing, it is hoped, how closely the course eventually taken corresponded to business logic. Any wide departure from 'economic rationality' may indicate defective entrepreneurship, perhaps including prejudices about the nature of the labour force. However, these exercises have often been inconclusive, even when conducted with the abundant data generated by modern industrial economies (Coleman & Macleod 1986: 598-9). They are much less likely to carry conviction when applied to the issue of the plough, on the basis of Caribbean slavery's relatively sparse documentation.

First, to repeat a point which has already been laboured, it is unclear what choices were in fact made. Perhaps our knowledge could be extended by the systematic use of probate inventories to produce a 'diffusion curve', of the kind used by analysts of more recent technical change, indicating how the proportion of British West Indian estates equipped with ploughs varied over time.¹⁰ But even with fuller information about the timing of

innovation, what could be said about benefits and costs? One Jamaican planter alleged in 1811 that by ploughing he had reduced expenses in land preparation from £10 to about £2 per acre, implying that the failure of so many others to follow his example was economically 'irrational' (Watts 1987: 430). Yet when work schedules were calculated on Jamaica during 'apprenticeship' in the mid-1830s, the cultivation of one acre of cane land, from planting until the time when its first crop became ready for cutting, was reckoned to take about 100 apprentice-days labour if the plough was used, and 120 days' labour otherwise (*British Parliamentary Papers* 1837-8: 42-82).¹¹

Estate accounts may occasionally indicate how much a planter had paid for a plough, but not its maintenance requirements or rate of depreciation.¹² Ploughing was usually introduced by indentured white servants, often imported specially for the purpose, men who from anecdotal evidence soon became martyrs to the West Indian climate, fevers, and rum. In fact we have very little idea how much white instructors cost their employers. The mortality of immigrant Europeans was not systematically recorded, but at least some white ploughmen could survive to be serviceable in other occupations,¹³ and when slave ploughmen appear in the estate inventories, the length of time that has been required for their training is not specified.¹⁴ Ploughing made extra demands on livestock, and a ploughed field was more subject to erosion than one left covered by a lattice of unbroken ground under the system of individually-dug cane holes. All other things being equal, no procedure could yield heavier crops than hoe cultivation and 'treading out' the manure – carrying the available supplies in baskets to be placed round the plants. But to the extent that livestock was improved by greater success with fodder crops – and during the later decades of slavery there was notable progress on this point in Jamaica, Barbados, and Antigua – the costs of animal traction and manure supplies relative to hand labour were reduced. The economics of ploughing cannot be disentangled from the general process of agricultural innovation (*British Parliamentary Papers* 1836: 269; Ward 1988: 61-79).

The choice between plough and hoe was also bound up with wider issues of slave management. It has been suggested that planters were reluctant to save labour in soil preparation, because on sugar estates a pronounced maximum in work requirements came at the sugar harvest. So increased efficiency in executing tasks at other times of the year would be of little value, and, by aggravating seasonal underemployment, perhaps also socially disruptive. This theory is unconvincing. All the evidence from the period of slavery shows that digging cane holes was a most stressful phase in the agricultural cycle, one that planters promoting amelioration were anxious to mitigate.¹⁵

Another and more reasonable idea is that masters had doubts about ploughing because, although they recognized slaves as competent for the task, skilled men, working outside the main field gangs, were seen as a threat to discipline (Craton 1978: 226). It is certainly true that at least by the mid-eighteenth century every British West Indian sugar estate had its complement of slave artisans – boilers, distillers, carpenters, coopers, etc. – but these posts were obviously essential for sugar production. In field cultivation the planter had a real choice between more and less sophisticated methods. Also, craftsmen and sugar factory workers could be employed within a confined space under close supervision, to limit sabotage and ca'nanny.¹⁶ For ploughmen, ranging over distant cane pieces with a variety of physical conditions, supervision and the monitoring of performance were more difficult. On Chesapeake tobacco estates, Kulikoff argues (it is not clear on what evidence), masters lost some authority when they introduced ploughs and carts. He states that this equipment was used by its slave operators to establish control over the pace of work. Nevertheless, the problem seems to have been manageable in the North American context: at least the plough was used widely here. But to what extent was this achieved because the region's slaves – relatively 'acculturated' by Caribbean standards, and employed in smaller units – were more easily disciplined (Kulikoff 1986: 406, 408, 412)?¹⁷

The significance of the slaves' skills for their masters' authority has also been raised as an issue by work on British West Indian slave revolts and conspiracies. In the early stage of settlement recently imported Africans were the most conspicuous as rebels. Then as time passed the leadership of popular uprising came to be taken by Creoles with special status, as drivers, craftsmen, and domestics. The tendency alarmed many white colonists, who complained that their trust had been betrayed (Gaspar 1978; Craton 1982). So how was the phenomenon seen as a problem of estate management? Were planters discouraged from employing their slaves in skilled occupations? Such a restrictive course was officially recommended after the Antiguan conspiracy scare of 1736 (Gaspar 1978: 312), but there is no evidence of it being followed.

On sugar estates in Barbados, the Leewards, and Jamaica, a steady increase occurred in the proportion of skilled slaves, from about 25 per cent of adult males in the mid-eighteenth century to about 40 per cent on the eve of emancipation (Ward 1988: 228). Were planters perhaps forced reluctantly along this path by the need to raise efficiency and cut costs, yet slowed down at every step by anxieties about indiscipline? There is no doubt that the tendency had economic causes: more craftsmen were

required as the volume of sugar output per worker increased and as equipment became more elaborate; and trained slaves were much cheaper to employ as specialists than hired whites. However, it seems unlikely that planters were seriously inhibited by security considerations.

First, skills were not seen as likely in themselves to be a source of danger or insubordination. Even if they gave their holders pride and self-confidence, they also brought privileges, however modest, which might be conferred or withheld as instruments of control. On early nineteenth-century Barbados it was reported that instruction of slave children in skilled trades 'is usually done to gratify the well conducted Parents and reward them for their good conduct....' (Taylor 1976-7: 71) Thomas Thistlewood's Jamaican diaries,¹⁸ from an earlier and darker age, give a more brutal dimension to the management process. They show how among the slaves on Egypt sugar estate, where he served as overseer between 1754 and 1767, men with special skills – for example carpenters or sugar boilers – were much less likely to suffer punishment, and, to judge by the relative infrequency with which they ran away, much more reconciled to plantation life. The craftsmen were also regularly employed to guard the growing crops against theft and to hunt down runaways (Ward 1979; Ward 1988: 27-9).

Equally detailed information is not available for other properties, but estate population listings imply a similar pattern of behaviour. When masters commented on their slaves' 'disposition', derogatory epithets – for example 'runaway', 'skulker', or 'thief' – were applied disproportionately to field labourers. Most compliments went to men with special responsibilities or skills.¹⁹ This pattern persisted up to the time of emancipation, despite the conspicuous part taken in rebellion by members of the slave elite. In the planter's view the primary causes of unrest were material deprivation and, increasingly, radical ideas from overseas, not the presumptions of skilled workers, even if some of them did appear as leaders when revolt broke out. (We need not consider here whether these perceptions were accurate or logical, merely that they provided the basis for policy.) The best safeguards of good order seemed to be reasonable treatment, close supervision and, above all, the curtailment of the anti-slavery agitation in Great Britain. The only way by which training slaves could be construed as a source of insecurity came in so far as the process displaced white workers. This was clearly the concern in Antigua in the 1730s, but subsequently it had little effect. By the later eighteenth century there were few white craftsmen left to displace on British West Indian sugar estates: the whites who remained were almost entirely supervisors.²⁰ So instruction for slaves, particularly in a quite new task like ploughing, made a net addition to the proportion of skilled workers.

CONCLUSION

I conclude, therefore, that slavery as an institution was not a major obstacle to the adoption of the plough in the British West Indies between 1750 and 1834. Physical conditions were the decisive influence on the rate of field mechanisation. Planters as a class had no particular fear of trained slaves, nor were they restrained by strong prejudices that slaves were incapable of acquiring new skills. Ploughing did not seem likely to cause major problems of seasonal underemployment. The use of ploughs was discouraged by slavery only in so far as it had the effect of making hand labour seem relatively abundant. The significance of concerns for labour saving is shown by the renewed interest taken by planters in ploughing after the closure of the slave trade from Africa in 1808, an interest which was confirmed and perhaps strengthened by emancipation in the 1830s. However, it must be stressed that British West Indian sugar planting between 1750 and 1834 was not by contemporary standards a 'cheap labour' economy. During this period the cost of acquiring and reproducing a work force rose more rapidly here than perhaps anywhere else in the world. This tendency resulted partly from market forces in the transatlantic slave trade, and partly from the political constraints imposed by the growing metropolitan anti-slavery movement. As a result, by the time of emancipation the material consumption levels reached by slaves in the British Caribbean roughly matched those of manual workers in industrialising Great Britain (Ward 1988: 261-3, 286-8). Under these conditions the sugar estates could be maintained only by making their labour force more productive, and to this challenge many planters proved capable of developing an effective response.

NOTES

1. Watts 1987: 423-47, while recognizing that some adaptation did occur, takes a more pessimistic view of British West Indian economic trends after 1720. I think that he does not give sufficient weight to the planters' capacity for technical innovation. His account relies too much on printed sources, and is not supported by quantitative measures of productivity.
2. Tudway MSS, Somerset Record Office, Taunton, Box 14, Montly Journals of Plantation Works 1823-9.
3. For an alternative recent view, that the use of the plough was declining in early 19th-century Jamaica, see Watts 1987: 431-2.

4. Vassall MSS, Sheffield City Libraries, Sheffield Record Office, MD 2047 (1), Letter Book of William Vassall 1769-86, J. Wedderburn to W. Vassall, 2 Aug. 1777.

5. Most attempts to introduce the plough were made with white immigrants, but it was clearly expected that these men would train slave successors: Vassall MSS, J. Wedderburn to W. Vassall, 2 Aug. 1777.

6. Institute of Jamaica, Kingston, Jamaica, MS 1069/3, J. Kerr to T. Hall, 24 Sept. 1777, concerning Irwin estate, Hanover parish, Jamaica.

7. Vassall MSS, W. Vassall to J. Graham, 4 Mar. 1795.

8. Fitzherbert MSS, Derbyshire Record Office, Matlock, W1/9, W. Sutherland to W.P. Perrin, 8 Feb. 1801. See also Edwards 1819: ii, 245.

9. Clarendon MSS, Bodleian Library, Oxford, Dep b 36, listings of slaves on Mesopotamia and Island plantations 1780-1802.

10. See, for example, Grilliches 1971: 208. Kulikoff 1986: 408, uses probate inventories to measure the increasing ownership of ploughs and carts by North American tobacco planters between the 1730s and 1770s. Similar sources are available for some of the British West Indies, but it is doubtful whether they provide sufficient detail to help with this problem. Many inventories held among estate archives do not specify individual items of equipment. Hall 1959: 96, presents statistics for imports of agricultural machinery in the 1840s. But official statements of colonial trade for our period do not in general define categories closely enough to identify deliveries of particular implements. A further problem is that plantations recorded as having ploughs might use them on varying proportions of their cane land. Thus in July 1834 it was hoped soon to completely replace cane holing with ploughing on Holland estate, St. Elizabeth parish, Jamaica. At the time the property held only one plough 'and it answers extremely well': Gladstone MSS, Clwyd Record Office, Hawarden, Ch 81, R. Gladstone to J. Gladstone, 28 July 1834. I suspect that the impression of increased ploughing after emancipation comes partly from the fuller use of implements that were already on hand. But to confirm this we would need much fuller accounts of cultivation schedules than usually survive.

11. For alternative estimates, see Green 1973: 458.

12. Thus the 'Inventory of Plantation Utensils, Stores, &c on Parham New Work Estate 1st Jany. 1824', fos. 6, 9 (Tudway MSS, Box 53), lists 5 plough animals, all imported since 1820, and 6 ploughs, 4 of them broken. But this exceptionally full archive seems to give no further information about costs. Correspondence may report that a plough has been broken, if the overseer wants a replacement: e.g. Clarendon MSS, Dep c 360, Bundle 8, W. Ridgard to J.F. Barham, 9 Oct. 1828. But if the matter is not mentioned, does this mean that the plough is still intact and in use, that it has been repaired on the estate, or that it has been given up altogether?

13. Thus while the Vassall MSS mentions the death of one white ploughman, and the interception of a second by a press gang, others, including a 'clever, useful man', appear and disappear without explanation: Vassall correspondence, 17 Oct. 1778, 26 June, 8 Dec.

1779, 4 Oct. 1780, 3 Jan. 1782, 4 Nov. 1783. However, on 2 Aug. 1777 Vassall's Jamaican attorney did regard the mortality of white men from fever as an obstacle to ploughing.

14. For slave ploughmen see Gale-Morant MSS, Exeter University Library, 3/c (York, Jamaica, 1778, 1782); Craton 1978: 226, 423, n. 8 (Worthy Park, Jamaica, 1784, 1794); Penrhyn MSS, The Library, University College of North Wales, Bangor, R.W. Fearon to Lord Penrhyn, 4 Oct. 1806 (Denbigh, Jamaica); Public Record Office, London, T. 71/1542 (Martin Byams, Antigua, 1830); Gale-Morant MSS, 4/c (Mount Hindmost, Jamaica, 1833); and the example cited above, n. 9.

15. I share the scepticism expressed on this point by Boomgaard & Oostindie (1989). For the stresses on slaves in the cane-holing and planting season, and for the particular concern of masters during the amelioration period to ease this part of the annual cycle, see Ward 1988: 15-29, 92-3, 215; Edwards 1819: ii, 248. Hall 1971: 22, quotes an Antiguan planter who had given up ploughing, because of the need to keep a slave holding occupied through the year. Hall's quotation is repeated (and attributed to Jamaica) by Aufhauser 1973: 817. It is just possible that on Antigua, the only one of the British sugar colonies to forgo 'apprenticeship' in 1834, planters felt themselves to be more encumbered with surplus labour than did their counterparts on other islands. But the case cited by Hall seems to be quite exceptional even for Antigua. The colonist quoted was the only one of eight local men examined about the possibilities for the use of machinery to reply in these terms (*British Parliamentary Papers* 1836: 274). Craton (1978: 226) mentions the fear of idleness out of crop as a reason against ploughing. But he acknowledges also that some authors, reading back from later practice, have exaggerated the 'five-month fury of the sugar crop' in the slavery period. Ploughing with free labour at Worthy Park during the early 1840s did not produce marked seasonal variations in employment (Craton 1978: 276-8, 295). Neither did it do so on the Parham plantations, Antigua (Tudway MSS, Box 53, wage sheets). Dunn (1984: 174-5) offers Mesopotamia estate, Jamaica, as representative of British West Indian conditions. He suggests that 'the slaves were given simple hand tools and no labor-saving devices. Much of their work would have been performed by draft animals in English or North American agriculture. Sugar was then as it is now, a seasonal crop, but the overseers stretched out the tasks to keep the slaves fully occupied at all times.' In my own reading of the records from Mesopotamia I have not found any support for this suggestion. The plough was used on the estate from the 1760s until at least the 1790s (Clarendon MSS, Dep c 357, D. Barnjum to J.F. Barham, 14 Sept. 1765; above, n. 9). If ploughing was subsequently given up here it is more likely to have been because of the stiffness of the local soils than any desire to spread employment through the year. In the 1820s attempts were made at Mesopotamia to reduce the labour of holing and replanting by extending the ratoons (Ward 1988: 92-3). In the 1840s, although the estate's manager claimed that he used the plough wherever possible, he could still quote rates of pay for digging cane holes in unploughed land (*British Parliamentary Papers* 1847-8: 192-3).

16. Green (1976: 51-2) emphasises how slave resistance to new implements confirmed planters' attachment to customary hand methods. An unusually detailed impression is given of the experience and attitudes of one planter through the diaries kept by Thomas Thistlewood, who worked as an overseer on sugar estates in western Jamaica for most of the period 1751-67 (Monson MSS, Lincolnshire Archives Office, Lincoln, Mon. 31/1-37). Thistlewood noted (18 Mar. 1751) 'That some negroe sugar Boilers purposedly will make no sugar to get the overseer turn'd out when they don't like him', but apparently never thought

that he himself had been the object of such an attempt. In his 16 years as a sugar planter he only recorded one suspected act of sabotage. On 7 Mar. 1767 the mill had broken down and he found a walking stick or cudgel lying nearby, after having been passed through the rollers. Thistlewood took a close interest in possibilities for technical improvement, although he never tried ploughing. He seems to have entertained no doubts about slaves' capacity for skilled work. On 25 Jan. 1762 he had the temporary loan from a neighbouring estate of the 'famous Boiler named Wille', who departed five days later with presents of money and two bottles of rum, and the diary comment: 'he certainly is a very good boiler.' On 9 Feb. 1762, while the mill was being repaired, Thistlewood remarked: 'Mason Quashie very handy about such things.'

17. Kulikoff notes that Chesapeake planters did not trust African slaves with any but the most rudimentary tools, and that ploughs were adopted as the proportion of creole slaves increased. I am not sure how significant creolisation was as an influence on the rate of technical progress in the British West Indies. Planters there gave a perceptible but not in overwhelming preference to Creoles over Africans in selecting for skilled assignments (Ward 1988: 228). Thus at York, Jamaica, in 1782 one of the three ploughmen was a 21 year old Eboe called Dennis (Gale-Morant MSS, 3/c). In the later 18th century the proportion of creole slaves stood at about 70% in North America but only 35% in Jamaica (Klein & Engerman 1978: 372; Ward 1988: 129). However, physical conditions were also more favourable to ploughing in North America. Some useful comparative perspectives might be gained from the experience of Europeans employing 'native labour' with the plough in colonial South Africa and Spanish America. I do not have the impression that adaptation in these areas was thought to be particularly difficult.

18. Monson MSS, Thistlewood Diaries.

19. This conclusion is based on an examination of the slave listings detailed in Ward 1988: 280-1.

20. Thus in the discussion of Jamaican slave revolts and the means to prevent them by Long (1774: ii, 404-504), stress is put on the need to encourage 'minor staples', grown by white smallholders, rather than the employment of white craftsmen on the sugar estates.

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